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MARCH-APRIL
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The Journal of The American Museum of Natural History

HAWTHORNE DANIEL
Editor

A. KATHERINE BERGER
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CONTENTS

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Photograph by Sir Baldwin Spencer *Courtesy of Macmillan*

AN AUSTRALIAN NATIVE IN CEREMONIAL DRESS

This extraordinary mask and headdress, as well as the design on the chest and arms, is made of tufts of cotton from a wild plant, stuck in place with human blood. Blood for this purpose is drawn from veins in the arms and applied to the skin with a small brush; the cotton is then stuck on and held firmly in place by the coagulated blood

VOLUME XXVIII

NATURAL HISTORY

NUMBER TWO

MARCH-APRIL, 1928

THE NATIVES OF AUSTRALIA'S "WEST"

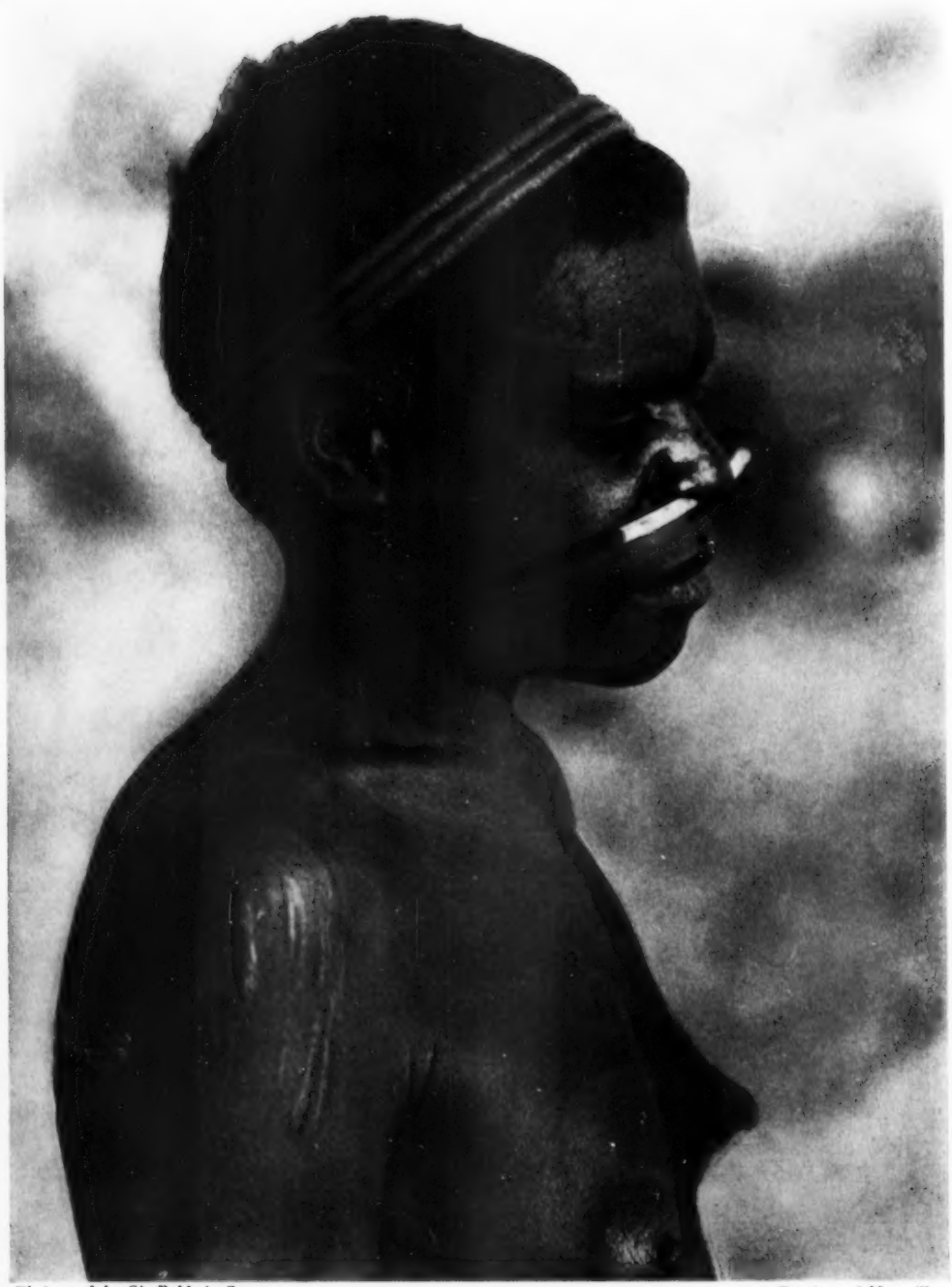
An Anthropologist's Account of the Native Australian Blacks

By CLARK WISSLER

Curator-in-Chief, Division of Anthropology, American Museum

IN Australia the natives are called "Blacks," and most people seem to have the idea that the ways of the Australian native are decidedly "dark." At least everywhere we find him cited as the lowest of the low. Ask anyone where the lowest savages are to be found and the chances are that the answer will be "Australia." However, white people who live among these Blacks often come to have a high regard for them and rise to their defense when such statements are made. It is true that when the first Australian settlers came in contact with the Blacks, they saw them as a naked, repulsive people, having no permanent abodes and given over to practices that offended. Naturally, the whites were shocked, and reacted in a way that calls to mind the story of a British colonial official who wrote in his report under the heading, Manners and Customs: "Manners none, customs nasty." But as is the case with all savages, the Australian Blacks improve on acquaintance and show themselves able to learn many things that other peoples do.

In 1925 I spent a few months in Australia, and, setting out from the city of Adelaide, made a quick trip westward to the edge of the open country, the present frontier of Australia. To realize what this means, think of St. Louis in 1865, when a journey of a few hundred miles to the west and north would have taken one through a fringe of villages and farms, fading out into an unsettled country in which roamed hostile Indians. What St. Louis was then to our frontier, Adelaide is to the Great West of present-day Australia. True, you can now cross the southern part of the Australian waste by rail, but so could one have gone from St. Louis to the Pacific after 1869. In either case the traveler would, for the most part, have launched out upon miles and miles of semi-arid plain. In this respect, the parallel between Australia and the United States is close. So today, as one travels west and north from Adelaide, the country grows rapidly dryer, water becomes scarcer, soon bringing one to the great sandy plains, where roam tribes of Blacks who are still to see their first white man,



Photograph by Sir Baldwin Spencer *Courtesy of Macmillan*

AIDS TO BEAUTY IN AUSTRALIA

The nosebone is widely used as an article of adornment, and the scarifications shown on this girl's shoulder are common among the Australians. Such decorations as these are popular with both men and women

Photograph by Sir Baldwin Spencer *Courtesy of Macmillan*

AN AUSTRALIAN FAMILY AT HOME

Brush shelters such as this are typical, and this is at least as well equipped as the average. The boomerangs, the spears, the knife, and the few bowls make up all of this family's worldly wealth except for the very important bone decoration that is thrust through the nose of the head of the house

for, as we have said, northward from the trans-Australian railway, to a distance equal to that from Santa Fé, New Mexico, to Medicine Hat, Canada, there are few outposts and no real settlements.

An American student now on the northern edge of this great wilderness writes that he has seen hundreds of natives who never before saw a white man. I was not so fortunate, but only because I did not have time to go the necessary five hundred miles farther to reach the heart of the wild country. Nevertheless, I did meet natives living most of the year by themselves beyond the range of whites.

Our friends in Adelaide, knowing that we were anxious to see the Black in his native country, had arranged in advance for a visit to a sheep station, or ranch, near Tarcoola, about five hundred miles westward, from which it was possible to reach the localities where camps of Blacks were to be expected. Accordingly, we took train at Adelaide, the party consisting of J. Burton Cleland, Brailsford Robertson, T. D. Campbell, and R. H. Pulleine of the University faculty in Adelaide, E. R. Embree and myself, from New York. By special order the train was to stop in the open country at a point near the sheep station where we were to be met by our host. It was early in the morning when we were dropped off with our baggage into the desert sand. No one was in sight. All about us was the stillness of the wild; the conductor waved us farewell as the train pulled out, and we gazed after it with the feeling that the last tie of civilization had been severed. A slight elevation on either side prevented our looking out across the plain, but after an interval we heard the familiar put-put of a Ford—no mistaking it anywhere—and presently two cars came in sight.

NATIVES DRESSED TO RECEIVE WHITE VISITORS

The local missionary had supplied some of the Blacks with clothes. One native woman immediately became the aristocrat of the camp because she obtained a corduroy skirt

They brought our host, Mr. McBride, the manager of the sheep station, and his two lieutenants, whose unfailing hospitality we were to enjoy for the next few days.

After a rest at the ranch house in company with our host, we set out in the two Fords to find a native camp which was said to be about ten miles away. The sand was covered with scattered low clumps of blue bush, looking for all the world like sagebrush, with here and there a squat tree, called mallee—the "water tree" of the Blacks. The sun was hot and the pulsing heat waves could be seen when one looked off toward the horizon. As we rode along, we were reminded of the plains of New Mexico and Arizona, so similar were the scenes before us. In the course of an hour, dodging in and about between bushes and trees, and occasionally sticking in the loose sand, we came suddenly upon some natives running about and shouting. They were hastily putting on such old civilized clothing as they had at hand, because, not expecting white visitors, they were following their original habits. Nowadays, all natives are required to clothe themselves when in the presence of white people, so those who do approach the settlements keep at hand at least an excuse for a costume. Some of the Blacks before us, as we saw later, had little more than rags to wrap around their hips. Our host was even more surprised than we were, because where he had expected to find a camp of three or four families, there lay before our eyes the tiny brush shelters of fifty families. It seems that the evening before our arrival at the ranch house, about forty adult men with their women and children, had arrived from the Musgrave Ranges to the northwest, a journey of several hundred

Photograph by Sir Baldwin Spencer *Courtesy of Macmillan*

SCARIFICATION IS COMMON AMONG THE AUSTRALIAN BLACKS

The ridges, or rolls, in the skin are produced by cuts treated with charcoal so that, in healing, these large raised scars result

PHOTOGRAPHING AN UNWILLING SUBJECT

Professor Pullein is operating the camera. Mr. McBride, the host of the visiting scientists, at his ease in the Ford, is amused at their enthusiasm over the Blacks, to him more trouble than they are worth. A Black boy is trying to comprehend the complexities of the car

Photograph by F. Garnett

MAKING STRING FROM RABBIT FUR

Before the rabbit was introduced to Australia, the fur of native animals was used in the same way. Human hair is also used for strings to make up the girdles, neck bands, head bands, and other parts of what little costume the natives wear

MAKING FIRE WITH A WOODEN FIRE DRILL
This native method of creating a flame is cruder than some similar methods, for the drill is rotated between the operator's palms instead of with a "bow" and cord. These men are in ceremonial dress

miles at best. The purpose of their coming was to perform certain sacred ceremonies and to initiate some of the youths living in the ranch camp; to induct them formally into full tribal citizenship, might be another way to put it. Nothing could have been more to our liking than thus to have the Blacks from the open country meet us half way.

So we stepped out of our Fords into the midst of a camp of Blacks. The reception was friendly, and when a native employee of the ranch explained as best he could that we were Americans living far away, the leading men of the camp shook hands with us, making little speeches, the words of which were meaningless to us, but the kindly import of which was evident.

The accompanying pictures will give some idea of what the camp was like. Whenever the Blacks make camp, they choose the side of a slight elevation or ridge; the reason is not far to seek. All serious ceremonies are for men only. Women and children are not to see them or even to visit the place where they are held, so, as no one can see over the ridge from the camp and the women and children are forbidden to go there, the sacred affairs of the tribe are safe from profanation. It is said that the usual punishment for spying upon the sacred ground is death. Such practices are common to all Australian natives and were known to us. Scarcely had we alighted in the camp, ere men began to approach over the top of this ridge. They were practically nude, but were decorated with paint and white down feathers. This, also, we knew to be the sign that a ceremony was in progress, and that was just the thing we longed to see. Not many white men have been permitted to see the sacred ceremonies of the Blacks, the best descriptions being those in the books of Spencer and Gillen, volumes

Photograph by Sir Baldwin Spencer *Courtesy of Macmillan*

A TYPICAL PROFILE

This profile view shows the sloping forehead and projecting brow characteristic of Australian Blacks and shows as well one way of dressing the hair

Photograph by Sir Baldwin Spencer *Courtesy of Macmillan*

HEAVY BROWS AND FLAT NOSES ARE TYPICAL

Australians are bearded and often hairy in body. This native's head appears bald in front, but that effect is artificially produced by pulling out the hair

familiar to all students of anthropology and sociology. When first we saw these decorated figures appear, we exclaimed, "They have stepped out of the book," for though they were not of the same tribes as were studied by Spencer and Gillen, they were closely similar, and in most respects were approximate replicas of the photographs in that book.

Perhaps one reason why the Blacks are considered so low in the culture scale is their simple way of living. They build nothing in the way of houses, merely making a sort of low wind-break of brush in front of which a fire is built at night, for as is the case in all dry countries, though it is hot during the day, the nights are cold. Their fireside furnishings are almost nothing: a digging-stick and a rude wooden dish; for the man a spear, a boomerang, and a short club, a stone flake or two to serve as a knife. These are the essentials. If to this we now add a few scraps of clothing, a tin can or two, a pipe and tobacco, we have listed all that white contact has added. The Black never stays long in one place and without notice may pick up his few belongings and trot off through the brush to a new camp. Nor are his food habits to our taste; when large game fails, which is the rule, he resorts to snakes and insects; then his cooking is little more than a gesture toward the fire. Water is too scarce to wash in, and his hair is never combed. I think most readers will agree that such a life as this is about as near the negative pole as can be.

Yet, your opinion of the Black will rise with acquaintance. He is happy, a good hunter, and above all knows how to live in the desert. Without canteen or water jar, he sets out boldly where a white would not dare follow. It is not merely that he knows where the few water holes are to be found, but that he knows how to

THE CEREMONIAL DANCE BEFORE THE SACRED TREE

The leaders stood in front and the men danced in half-circle formation, moving the feet sidewise

THE CEREMONY BEGINS

Circling clockwise about the decorated tree, the men who take part in the ceremony end by running to the tree and striking it. After the ceremony the decorations are obliterated and marks in the ground around the tree are swept away with the branches of trees. Women and children are not permitted to see the ceremonies

get water from plants. The mallee tree is his canteen. One of the Blacks in camp obligingly dug the earth away from the root of a tree, broke out a section of the root, put one end into his mouth and blew; water trickled out of the other end; by sucking, the water would go into his own mouth. Many of the desert blooms are rich in honey, and taking a note from the bee, the native picks the blooms as he trots along; these serve for both food and drink. These are but a few of the ingenious things the Blacks do, showing that they are far from stupid, and, as we observed, they can be friendly, if they choose.

As I have said, every man in this camp had a long wooden spear; some of these had bone points, but usually the natural wood was merely shaped. These they can throw with force and skill, easily and at some distance killing a man or a kangaroo. Also, each carries in his belt a boomerang and a short club, for killing small game and birds. These they can throw with great precision. There is much misinformation abroad concerning boomerangs, the general belief being that they return to the thrower; but the ordinary boomerang, the one used as a weapon, does not return; it revolves when thrown, and with such force that it can cut open a cheek or thigh if it strikes properly. It is a surprisingly effective weapon. Of course, some boomerangs do return; when we made it understood that we wished to see one, the whole camp was ransacked, only to produce two small, poorly made examples, not at all comparable to the handsome, efficient-looking boomerangs

A CEREMONIAL TREE

On the trunk, painted in red, are the mysterious symbols, the significance of which is known only to those taking part in the ceremony. Women and children are not permitted to see either the tree or the ceremony

thrust under the belts of the men. To be returnable, the two halves, or blades, of the boomerang must be in slightly different planes. So far as we could learn, those of the returnable type were used as toys, because their movements are too uncertain to be depended upon to hit what they are aimed at. However, in hunting water birds, they may be used to drive the flock toward the land and so within reach of the hunter, whereupon the birds are knocked down by the ordinary boomerang. One of the Blacks demonstrated with the returnable one; it sailed around somewhat erratically, circling back, but not quite to the feet of the thrower.

Meanwhile preparations were being made for the sacred ceremonies to be held on the other side of the ridge. In the afternoon the men went to the ceremonial ground, giving us to understand that we could come later. After a time two old men came for us; we walked between them, abreast, while they beat two sticks together and sang songs; four times we paused for a few minutes, approaching the ceremonial place not directly, but circling clockwise. Here we found our friends standing in line around a tree, the trunk of which had been painted, as shown in the photographs. As soon as we were in position, the ceremony proceeded; this consisted of dancing in a circle and finally rushing up to the tree. At the conclusion of the ceremony, certain marks upon the ground were obliterated by the feet and were brushed over with branches of trees, after which we returned to the camp, but not until the leader of the ceremony had laid upon us the injunction that none of their women should be told about what we saw. When back in camp one old Black woman harangued us; all we could make out of it was "that now we should soon

Photograph by F. Garnett

AUSTRALIAN WEAPONS

These natives are demonstrating the use of shields and stone knives. The man at the left is about to throw a boomerang, but the dogs find nothing of interest in this sham battle

die for having gone where we had no right to be."

"But," you may ask, "what was the meaning of this curious procedure?"

That is too much to explain in detail here: Most Australian tribes are divided into family groups, each group having a totem. This totem is usually an animal or a plant, and though not looked upon as a god, yet it holds a serious relation to every member of that group. With the belief goes a ritual which must be observed at certain times of the year. What we saw was the totem ritual of the group whose camp we visited. Similar ceremonies are described in detail in the books of Spencer and Gillen.

The natives were very anxious that we should stay for the festivities of the night —the "corroboree." Many writers speak of the "corroboree" as a sacred ceremony, but it is more in the nature of a social event. It takes place in the camp and all can join in, old and young. Before sunset we returned to the ranch house for a rest, and drove back to the camp after dark. As we neared the camp the Blacks waved burning branches to pilot us to the dancing ground. A space had been cleared of bushes and the roots grubbed up so as not to injure the feet. On the sides, brush had been piled, to be fired for tableaux effects, for what good is a dance, if no one can see it? Some old men sitting in a row on one side motioned me to a seat beside them on the sand. Most of the dancing was by women and girls; without clothing, their dark bodies painted with white lines, they danced in two files, holding their feet together and jumping up and down, in perfect unison, back and forth across the ground. The effect was barbaric but pleasing, and as a dance it was well executed. The old women and men

PART OF THE NATIVE ENCAMPMENT

Showing the sandy-like soil, the low, stunted brush, and occasional trees. These natives were sufficiently sophisticated to own pieces of canvas to cover their brush shelters. The swinging stride of the second girl is suggestive of the walk of occasional negresses in our Southern States

sitting around sang, while two men near me beat time upon the ground with their throwing clubs. After the dance by the women, the men staged a few performances, one of which, representing the capture of an enemy, was especially successful. We greatly admired the way the evolutions were timed in the glare of lights when the piles of brush were lighted, and were sorry when the Blacks announced that the show was over. Unfortunately, no photographs could be taken, for we were without flashlights, but the unusual beauty of that "corroboree" has left a picture in our memories that will never grow dim. That the Blacks enjoyed the æsthetics of the scene we knew from their beaming faces; one of the old men sitting near me knew a few words of English and would frequently turn and say, "Pretty, pretty."

The different races of man have individualities. Experienced travelers feel these distinctions, but always find it difficult to express them. Entering a village of African Negroes, such an experienced person would expect the little community to react to his presence in the characteristic African way; visiting the Eskimo, a different reaction would be expected, but to put these experiences into intelligible words is impossible, because they are matters of feeling rather than of logical analysis. One can, however discuss one experience in terms of the other. Thus, at first sight, the dark color and broad noses of the Blacks remind one of Negroes, but once in their camps the reaction of the group is not at all what one would expect from Negroes. Then, again, it is not like what one expects in a camp of American Indians, but the attitude of the Black is nearer that of the Indian than of the Negro. If, on the other hand, we

compare the attitudes of all three with what we expect when entering a strange white community, then it seems that the Blacks are nearer to the whites than they are to the Negro or the Indian. And this is in spite of the unsavory reputation of the Black—in spite of his revolting practices and his material poverty. He is not so demonstrative as the Negro, nor so stolid as the Indian, but more like a backwoodsman in our own country who meets you frankly on a common plane. This may seem hopelessly contradictory to the reader, but so is the life of the Black—interesting and absorbing in some of its phases, and disgusting in others.

As I have said, the Australian Black is given a low rating in the human scale, probably because he sometimes shocks white people, but a much more sericus charge is made against him by cold-blooded scientists. To them, his offensive habits are a matter of no moment, for they see in his bones the marks of our simian ancestors. The portraits accompanying these pages show the Australian head as narrow and long; the forehead is rather low and the brow ridges are bold and heavy, with the root of the nose deeply underset. The profile also shows the mouth thrust forward even more than is usual among Negroes. Finally, the nose is broad and flat. Comparative anatomists look upon certain of these traits as placing the Australian nearer the early ancestors of man than other living races. Nevertheless, the Australian is nearer the European type than the extinct forms of man, such as the Neanderthal, and in that sense is regarded as a modern type. If we

A CLOSE-UP OF A NATIVE HOME

If the native is so fortunate as to secure a piece of canvas, or even some old rags, these may be thrown over the top to aid in warding off the heat of the sun

reduce all this to a simple statement its import will be that the Australian is a suggestion of what all men were at the beginning of the modern period, or to put it another way, in bodily and facial development he has not quite caught up with the other living races.

The reader may have been struck by the heavy beards shown in the pictures. When we look at mankind as a whole, it appears that heavy beards and thick body hair belong to the peoples of Europe, North Africa, Southwestern Asia, and Australia. In contrast, the Negro peoples, Malays, Mongoloids, and American Indians, all have scant body hair and almost no beard. Looking at a map of the world, we observe the zone of heavy beards to run from the British Isles over Europe through Southwest Asia into Australia, while on either side are peoples with very sparse beards. This is a curious geographical segregation of this anatomical peculiarity, the meaning of which is not obvious.

Finally, no evidence has come to hand, indicating that any other people lived in Australia before the Blacks, while, on the other hand, there are indications that they entered the country a very long time ago and that no large amount of new blood ever reached the continent until the period of European settlement. So, for ages, the Blacks lived in relative isolation, untouched by the great culture changes and achievements in Europe and Asia. This may be one reason why they seem to us so barbaric and so crude, so reminiscent of what one conceives the Stone Age to have been.

RIVERS THAT FLOW UNDERGROUND

Unfamiliar Streams That Carve and Preserve Their Courses Through Untold Millenia

By CHESTER A. REEDS
Curator of Geology and Invertebrate Palæontology, American Museum

Till taught by pain
Men really know not what good water's worth;
If you had been in Turkey or in Spain,
Or with a famish'd boat's crew had your berth,
Or in the desert heard the camel's bell,
You'd wish yourself where Truth is—in a well.
—Byron.

PERHAPS the most unique rivers are those hidden away in the depths of the earth. These subterranean streams are of great interest, not only because they have characters peculiarly their own but since the striking features of their abandoned courses are oftentimes wonderfully preserved in various caves, and may be readily examined. Most of these underground streams join the surface streams before they have attained any considerable size, hence they are usually of short length and have outlets consisting of dark cavernous arches, or, more often, of one or more large springs issuing from the ground.

The subterranean streams of limestone regions are notably variable in their discharge, not only at different seasons of the year, but in different areas. Variability in rainfall is a prime factor. Another cause is the position of the water table—that is, the upper surface of the ground water—with respect to the water levels of former ages. For instance, in a region where the land and the water table have remained constant with reference to sea level, a nearly complete and perfect underground drainage system may be developed with cavernous rock above the level of the underground drainage and a very tight rock below this level. Such a network of joints, sink-holes, and underground passageways lacks storage capacity and discharges its waters swiftly after a rain. Its outlets fluctuate violently, in extreme cases discharging torrents of muddy water in wet seasons and becoming entirely dry in periods of drought. Some of the underground streams and big springs of the Ozark region, Missouri, are of this type.

On the other hand, where a limestone district has subsided, with reference to sea level, great systems of caverns may be submerged beneath the water table and may function as large subterranean reservoirs that equalize the discharge. The underground rivers of this type are perennial and relatively constant, and their springs discharge clear water even at times of heaviest rainfall. The large springs of Florida belong to this relatively constant type.

It is in those caverns which have remained stationary, or which have been elevated with reference to sea level, that the most interesting underground rivers are to be found. The channels of such rivers are far from being smooth, with graded bottoms. They vary from narrow, tortuous defiles to wide and lofty galleries hemmed in by precipitous rock walls. The floor is apt to be uneven, with pits, potholes, and waterfalls occurring at frequent intervals, while sand-strewn and gravelly bottoms are rare. Huge masses of rock, either in place or fallen from the

AN ABANDONED SUBTERRANEAN WATER COURSE

This dry stream bed in the Endless Caverns near New Market, Virginia, shows etched and fluted surfaces on the ceiling and undercut banks in the lower levels

ceiling, may block the way. The roof may grade downward into the water, obstructing farther progress while the stream passes beyond through a submerged tunnel. Along the banks of such a course, reddish clay either of a slippery or sticky consistency remains, following the recession of storm waters. Oftentimes in exploring underground streams one has to lie flat on his stomach and wriggle along on narrow sloping shelves of rock, over an abyss, perhaps, or crawl on hands and knees through cool running water, carrying his candles, provisions, flashes, and camera as best he may. In the darkness of the subterranean world danger lurks near, and it is not advisable to attempt to negotiate such passageways in parties of less than three persons.

In the Endless Caverns of the Shenandoah Valley, near New Market, Virginia, half a mile of the abandoned course of an underground river has been electrically lighted and opened to tourists. The peculiar etchings made by the acidulated waters of such a stream are so well preserved that they appear to have been left only yesterday, yet the growth of many large stalactites, stalagmites, stony curtains, and shields denote that it was many centuries ago. In this same cavern and very close to that interesting grotto known as Solomon's Temple, there is a great chasm. As one looks over the protecting parapet one detects, at the very bottom, the rippling surface of an underground river, that long ago left its former course and now shimmers and scintillates far below in the glow of recently installed spotlights.

In 1925 the writer was one of a party of eight men, five of whom were from the Explorers' Club, New York, who undertook to follow this subterranean river upstream

Photograph by Eugene J. Hall *Courtesy Louisville and Nashville R. R.*

THE RIVER STYX, MAMMOTH CAVE, KENTUCKY

It is estimated that the waters of this river are 400 feet in length by 40 feet wide

and downstream. By means of a rope, the party wound its way down over slippery walls to the clear stream at the bottom. Here the water was cool and shallow, and the ceilings so close at times that we were obliged to stoop. In some places the ceiling was as low as eighteen inches, and the only way we could proceed was to lie flat in the rushing water and squirm along. Then we would come out into fairly large chambers where we could stand up and stretch. It took one and one-half hours to cover two hundred yards in this manner. Progress upstream was stopped by the ceiling descending abruptly into a deep pool of water. It may have been possible to dive under this obstruction, but it was not deemed wise to attempt it before exploring a side avenue. But this was blocked by a growth of huge stalactites and stalagmites, and, after noting raccoon tracks in the red mud, we essayed to return to the point of entry and to proceed downstream in an endeavor to find the outlet. This part of the trip was more interesting, for the chambers were larger and the ceilings were not so low. The red mud, however, was more plentiful and the sloping shelves more treacherous. Twice we reached places where it was impossible to follow the actual stream bed, but in both instances we found passages above which led to the water beyond. After much scrambling we came to a "Fairy Fount," to a perfect likeness of an "Elephant's Head," and to a "Silent Waterfall," over which the stream dropped some ten feet. Having left our ropes dangling at the point of entry, we could not proceed farther, so we placed the following label in a bottle and turned back:

THE MARINE CORRIDOR IN THE ENDLESS CAVERNS

Showing the junction of two abandoned underground stream channels, one to the left and the other to the right of the surveyor's rod. The dark limestone rock in the wall near the foot of the standard has been blasted away to provide a wider passage for tourists

Courtesy of the Ocala Chamber of Commerce

SILVER SPRINGS, NEAR OCALA, FLORIDA

Sufficient water wells up from a submerged cavern 65 feet wide by 12 feet high to form a large river. The lowest registered flow was 342 second-feet in February, 1917, the highest 822 second-feet in December, 1898. A second-foot, that is, 1 cubic foot a second, or 448 gallons a minute, would be regarded as a remarkable spring. One of 822 second-feet, or 368,256 gallons a minute, or 530 million gallons a day, is highly unusual. Only two other springs in the United States, namely, Malade and Thousand Springs, in Idaho, have registered larger flows. The water of Silver Springs has a bluish tinge, but it is so clear that the chalk-white limestone bottom, the aquatic vegetation, and schools of fishes can be seen readily through glass-bottomed boats

This bottle is placed at the farthest point penetrated by members of the expedition of the American Museum of Natural History and the Explorers' Club of New York, May, 1925. If anyone finds it and can carry it still farther, please report to the American Museum of Natural History.

Two hours later we reached the hanging rope and ascended hand over hand into the main passage of the cave, having spent seven and a half hours trekking along the course of the underground stream.

After resting from this hazardous trip, we proceeded to the far end of the tourist section of the Endless Caverns and spent twelve hours exploring unknown passages and another portion of the underground stream. The end of the Caverns was not found, but a second label was left in a bottle where the stream tumbles down over a high subterranean wall.

Although this underground stream was not followed to its limits, a farmer complained, following our subterranean exploits, that his spring had suddenly become riled. I visited the spot, and found four large springs emerging at the head of a deep valley. After a survey of the tourist section of the cavern had been completed, a level line was run from the cave entrance to the springs, and it was discovered that these springs are 11.5 to 13.5 feet below the stream bed at Solomon's Temple.

One of the best known underground streams is River Hall of the Mammoth Cave, Kentucky. It is but a portion of the great labyrinth of cavernous passage-

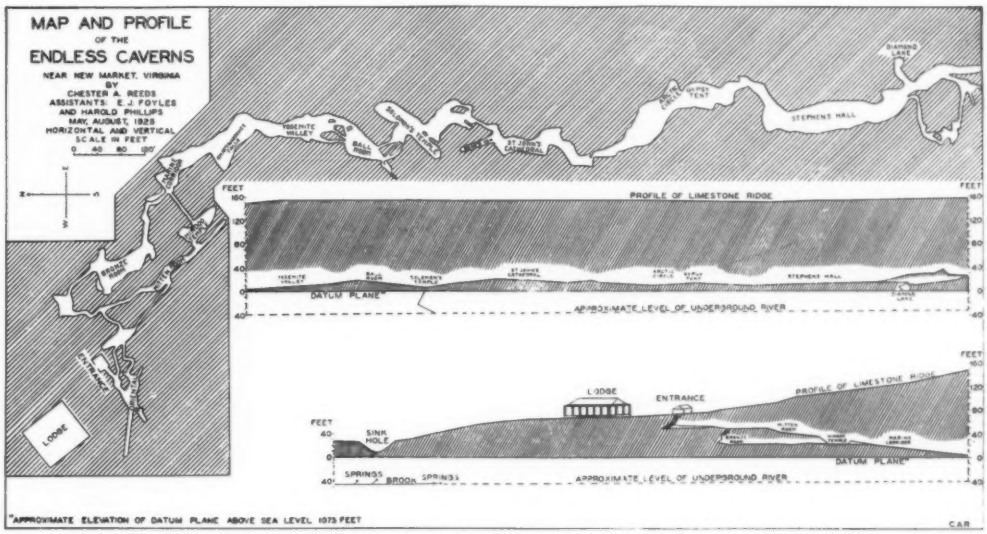
ways, which constitute the lowest level of five successive series of galleries in this immense cavern. This great subterranean watercourse is the gathering bed of the rain waters, which enter the caverns largely through thousands of sink-holes that open down from the surface.

The more prominent water passages of River Hall have received the following names:

A quiet pool of fresh water more than a hundred feet long has been called the DEAD SEA. Eyeless fish and other aquatic animals are found in it. Beyond and around a wall of rock may be found the RIVER STYX. The dark waters of this river are estimated to be four hundred feet in length by forty wide. In a lofty and spacious hall beyond the River Styx appear the placid waters of LAKE LETHE of about the same size as the Styx. Next follows the GREAT WALK about four hundred yards in length, with a floor of fine yellow sand five feet above low-water mark and ninety feet below the ceiling. The stream alongside is twenty feet wide and contains the blind white crayfish, *Cambarus pelucidus*. Next comes the calm and unruffled water of ECHO RIVER with three arches, through any one of which a boat may be launched. The first arch is about three feet above low water, and if the river has risen, it is necessary to embark from the second or even the third arch, which is thirty feet above the water. Barometer readings indicate that the surface of Echo River is about twenty feet above the level of Green River. Echo River is about half a mile long and varies in width from twenty to two hundred feet between its precipitous walls. Myriads of cavities varying from a few inches to many feet in diameter occur in the enclosing walls. They are in part

FALLEN SECTIONS OF THE CEILING

Huge blocks of limestone, detached from the ceiling, not only retarded the progress of the writer's exploring party in the Endless Caverns, but they hid from view the underground river which flows at a lower level



SKETCH MAP AND PROFILE OF THE TOURIST SECTION OF THE ENDLESS CAVERNS
This drawing is by Chester A. Reeds assisted by E. J. Foyles and Harold Phillips. The approximate relations of the underground river and the outlet springs to the electrically lighted portion of the cavern are shown in profile

responsible for the echoes and reverberations developed on this stream. ROARING RIVER appears some distance beyond. It is difficult to traverse, being a succession of shallow ripples and deep basins navigable only by a portable canoe.

When Green River, the near-by surface stream, rises, River Hall becomes flooded, forming a vast continuous channel of water two miles long and varying from thirty to sixty feet in depth. Under such conditions, the River route through the cavern is impassable to tourists. The outlet for such a great volume of water is not definitely known, although deep bubbling pools have been noted along the banks of Green River at various places. It is probable that when engineers of the United States Government make a detailed instrumental survey of Mammoth Cave, including the surface of the ground and the approximately one hundred and fifty miles of passageways underground (a matter which the former owners of the cavern did not permit), we shall have a much better understanding of the movement and the outlets of these subterranean waters.

Other underground streams occur in the United States, but few of them have been explored or described. Reference to them is confined largely to newspaper articles on caves. Some American caverns such as Luray, have no underground streams, but instead, have pools of water beset with beautiful cave formations. The Wind Cave of the Black Hills is a dry cave. In some places, such as Bermuda, caves are found where no streams or wells of fresh water occur. There are, however, many lakes in the Bermuda caverns which show that they are connected with the sea by subterranean passages, because the waters within the caves rise and fall with the tides outside. Many caves in other parts of the world contain underground rivers, but in a brief article such as this, it is possible to cite only a few additional examples.

The celebrated French explorer of caverns, E. A. Martel, in his volumes *Les Abimes* 1894, and *Traite des Eaux Souterraines* 1921, calls attention to a considerable number of underground rivers in Europe, particularly in his native country, France.

AN ETCHED CEILING IN AN ABANDONED WATERCOURSE

Thes odd features in Endless Caverns are not stalactites or secondary deposits of lime carbonate, but are irregular surfaces of the original limestone rock dissolved out by the acidulated waters as they flowed past thousands of years ago

Ewing Galloway

THE "HINDU TEMPLE" IN THE ENDLESS CAVERNS

Showing the uneven surface of a dry watercourse. Huge stalactites, stalagmites, columns, and stony curtains, all representing secondary deposits, border the ancient stream bed. Joints in the ceiling, some sealed with calcite and others supporting small stalactites, show the places where the ground-water seeps through the limestone rock

Ewing Galloway

"SOLOMON'S TEMPLE" IN ENDLESS CAVERNS

The "temple" occupies a position about halfway along the tourist trail. In May, 1925, the writer's exploring party with supporting rope, entered the dark pit beside the stone balustrade and, after winding down over mud-covered slopes, reached the underground river, a vertical distance of 44 feet

Courtesy of Endless Caverns

A NEAR VIEW OF AN UNDERGROUND RIVER

This stream flows beneath Solomon's Temple, Endless Caverns, Virginia. In the center and right background a great mass of wet flow-stone fringed with drooping stalactites sparkles in the glow of the incandescent lamps. The ground-waters from higher levels are oozing down over its surface to the river

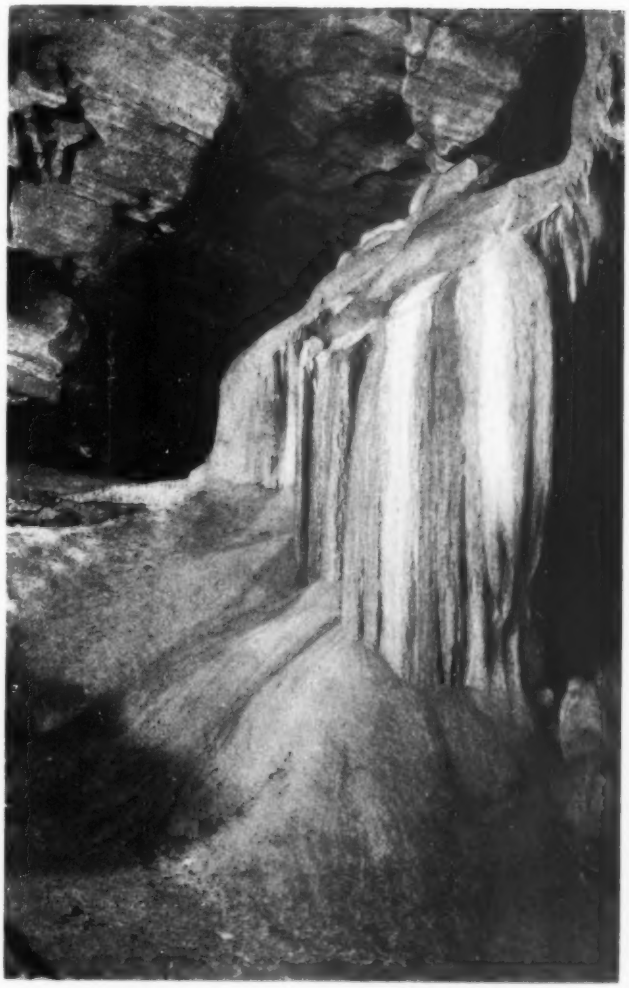
EXPLORING AN UNDERGROUND STREAM
Members of the writer's exploring party clambering down over precipitous and peculiarly carved walls in their endeavor to reach the subterranean river in the Endless Caverns

He states that near the village of l'Isle sur Sorgue, about fifteen miles east of Avignon, the fountain of Vaucluse breaks violently from a rock fissure at the base of a two-hundred meter cliff to form a considerable river, the Sorgue. The volume of water emanating from this fountain head fluctuates enormously from 4500 liters to 150,000 liters a second. Since this water emerges from a natural siphon, which is at least fifty-five meters in vertical depth, and inclined at an angle of from fifty to sixty degrees, it has been impossible to explore the subterranean course of the stream, although the catchment basin for this fountain is seventy kilometers long by five to twenty-six kilometers wide, with more than forty considerable sink-holes or avens in Neocomian limestone.

The Bonheur River in the department of Garol, on the north slope of the Cévennes, disappears into a complicated series of caverns totaling more than 6350 meters, reappearing under the name of the Sramabiau. In the caverns the river divides into three channels, and for about six kilometers its passages are unknown.

In the district of Carniola, Jugo-Slavia, and about a mile from the market town of Adelsberg, is the entrance to the famous stalactite cavern of Adelsberg, one of the largest and most magnificent in Europe. The River Piuka enters the cavern sixty feet below its mouth and has been explored for 2700 meters. After passing through a siphon of 700 meters, the river disappears for 2400 meters to reappear in the cavern of Kleinhaüssel, where its course has been traced for 2500 meters. The total course of this stream underground measured by fairly direct lines, is 8.9 kilometers, or about five and one-half miles. The Magdalene grotto in this cavern is celebrated for the subterranean amphibian, *Proteus anguinus*, which is about a foot in length, has both lungs and gills, and lives on snails and worms.

The Pecca River in Jugo-Slavia, after an open course of sixty kilometers, runs for 300 meters through the cavern of Mahorčič. The stream reappears in an open sink-hole, the lesser doline of Saint-Canzian, and after passing under several natural bridges, it enters a second sink-hole, the great doline of Saint-Canzian. The total open course of the river in the dolines is 400 meters. It then disappears again to follow an underground course, which has been explored for a distance of 2.1 kilometers. The Pecca is a torrential river, and frequently varies several meters in height within a few hours. In 1892 the river rose fifty meters. A total of thirty-six cascades appear along its underground route. After entering the siphon of the cavern of Saint-Canzian the course of the river is unknown, but it is supposed to flow underground to Timavo on the Adriatic coast, a distance of thirty-six kilometers.



Courtesy of Endless Caverns

A "SILENT WATERFALL"

A cascade of "flow-stone" in Endless Caverns over which the lime-impregnated waters flow so gently that not even a gurgle is heard

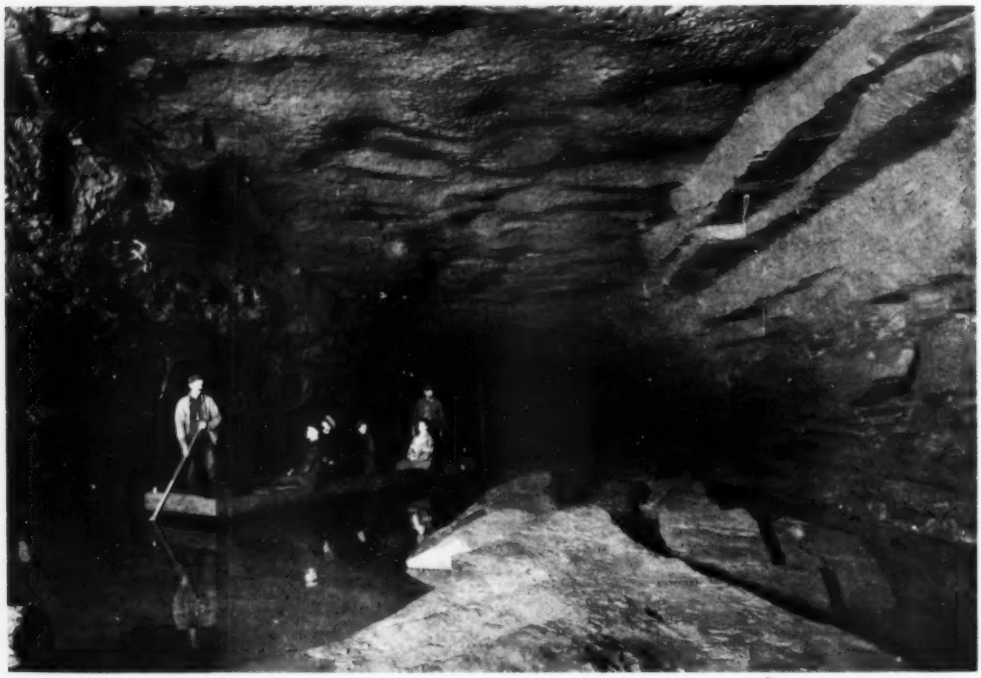
In the central Peloponnesus of Greece, in the plain of Mantineia, seven drainage basins find outlets through caverns into the gulf of Corinth. Many of the small interior valleys throughout the peninsula have no outlet, except through such caverns. The ancient Greeks paid considerable attention to keeping the mouths of the caverns clean and drainage in good order. Under the Turks, though sporadic attempts were made to clear the encumbered drainage, and grills were kept at the mouths of caverns, the underground courses became so obstructed that malarial marshes formed at the mouths of many of the larger valleys. In the earlier years of Greek independence this condition grew even worse.

The few examples of underground rivers cited from the United States, central France, and southeastern Europe are typical of the karst, a limestone plateau on the eastern coast of the Adriatic. Karst regions are characterized by (1) "lapiez," irregular furrows developed by combined erosion and solution in the rock

Courtesy of Endless Caverns

ANOTHER VIEW OF THE UNDERGROUND RIVER IN THE ENDLESS CAVERNS

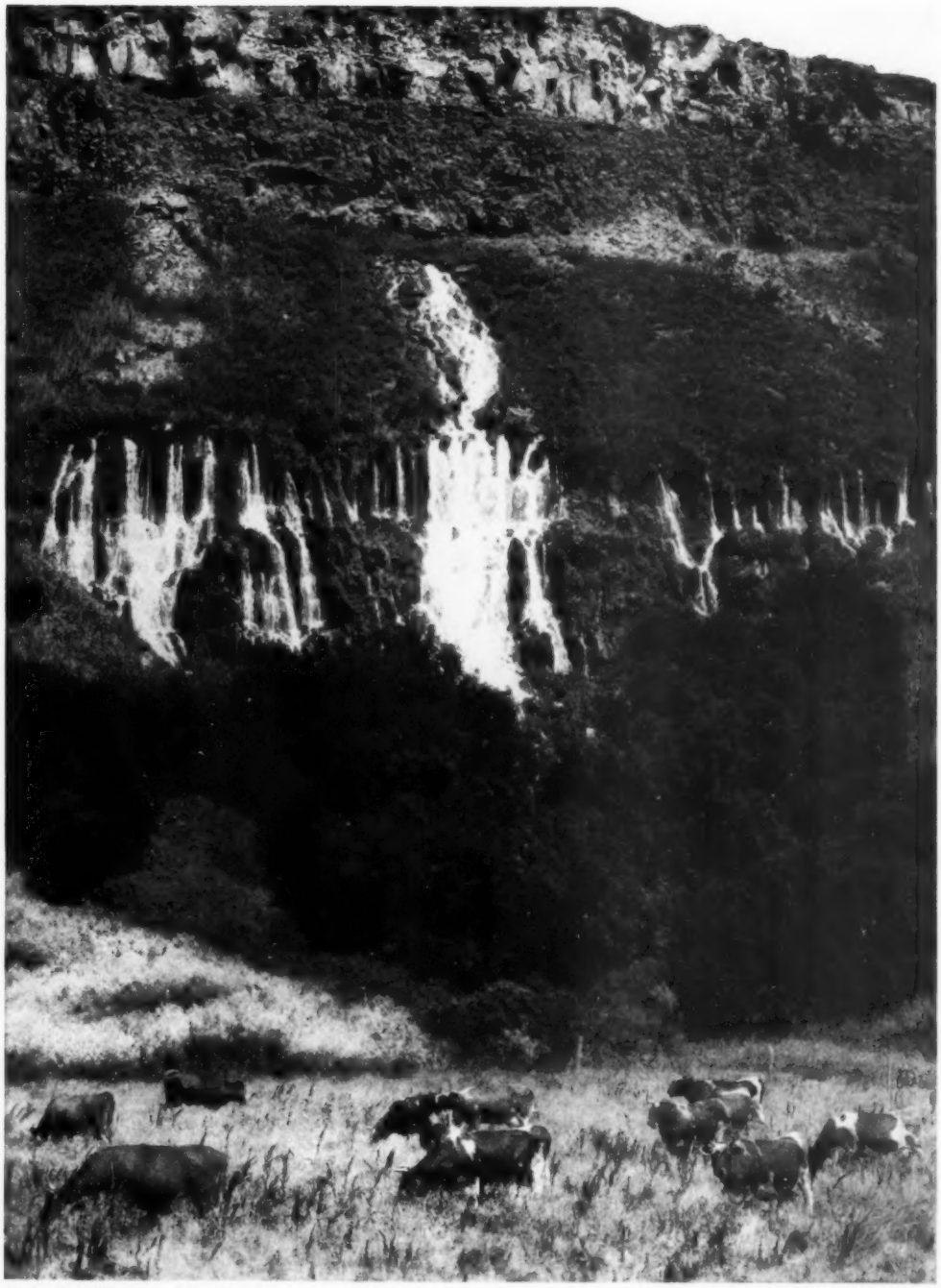
In addition to the drooping stalactites which reach to the level of the stream waters, others may be seen dangling from rifts in the ceiling. The meandering course of the underground river and the steeply sloping mud-covered banks are apparent



Photograph by Eugene J. Hall *Courtesy of L. and N. R. R.*

"ECHO RIVER," MAMMOTH CAVE, KENTUCKY

Flat-bottomed boats propelled by guides are the only means of transit along the half-mile course of this famous stream. In the right foreground may be seen a huge slab of limestone, broken into various blocks, which formerly occupied a position just below the present ceiling



Idaho State Chamber of Commerce *Courtesy of the U. P. R. R.*

A PORTION OF THOUSAND SPRINGS, SNAKE RIVER, IDAHO

One series of the numerous large springs emerging from the base of a highly jointed and vesicular bed of lava. In 1920, Thousand Springs registered a flow of 864 second-feet or 557 million gallons of water a day

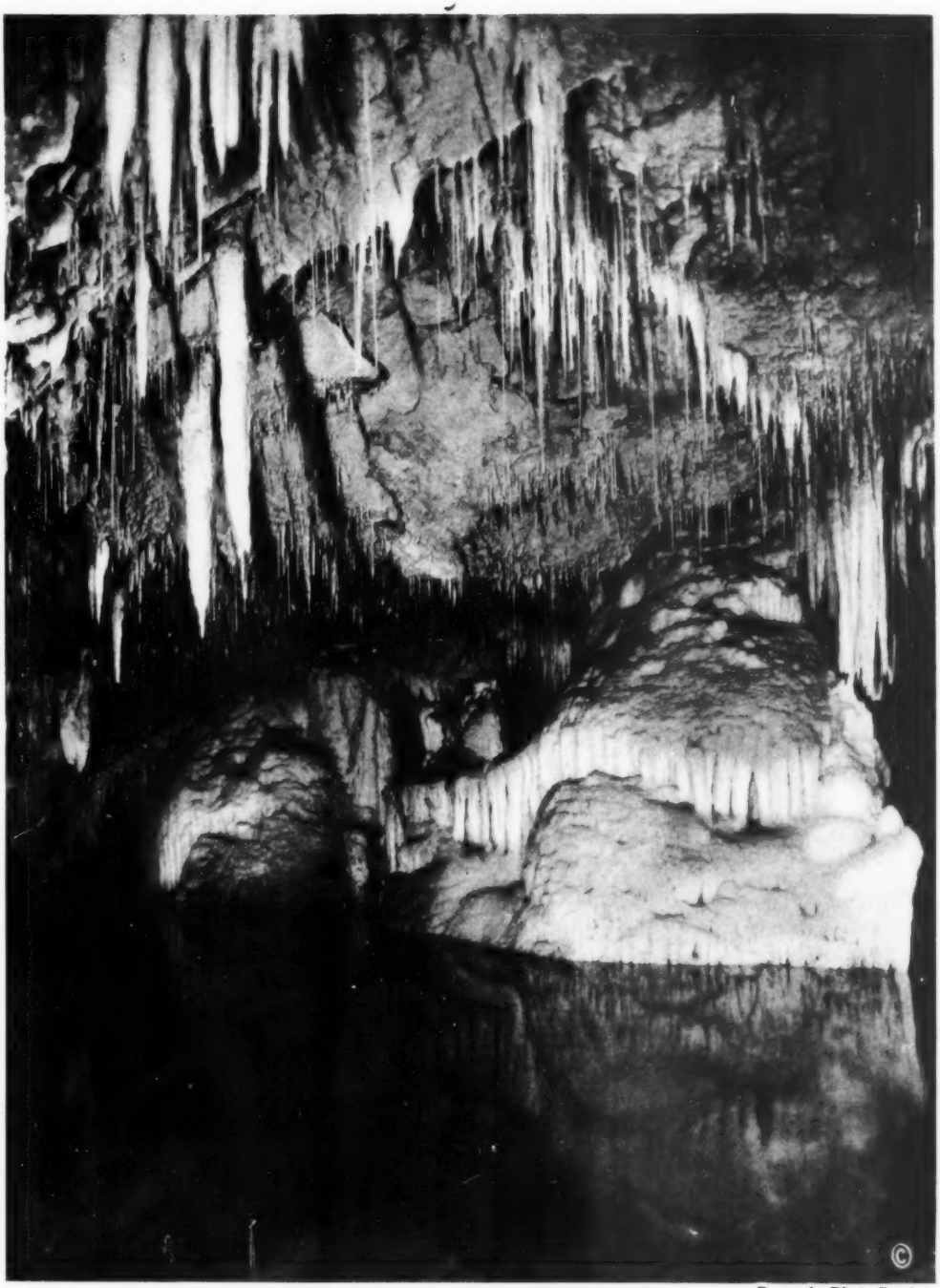
DREAM LAKE, LURAY CAVERNS, VIRGINIA

Pools of clear water abound in various parts of this cave. The water is so transparent that it is deceptive to most visitors. As may be noted in the left portion of the view, numerous small stalactites are reflected in the waters of the lake

fissures of limestone surfaces; (2) "dolines" or "sink-holes," funnel-shaped openings; (3) "ponors" or "avens," cylindrical shaftlike apertures; (4) "uvalas," large depressions of one or more kilometers in diameter; (5) "poljes," blind linear valleys; and (6) "hums," remnants of porous limestone. In the development of these features, the water of a karst region leaves the surface and circulates almost entirely underground. The rivers do likewise, and since karst topographies are developed on limestone and dolomite rocks in many parts of the world, it is in such areas that we should look for underground rivers.

Underground rivers are developed sometimes beneath extrusive volcanic rocks. One of the most striking instances of this kind is to be found in the Snake River basin, Idaho. For forty miles along the cañon of Snake River below Shoshone Falls, where the river has cut through the water-bearing lava beds, many beautiful springs produce a volume of more than 5085 second-feet[1] of ground water, that is, an average of 3280 million gallons a day or almost twice the consumption of water in New York, Chicago, Philadelphia, Cleveland, Boston, and St. Louis, during 1916. In 1920 Thousand Springs, issuing from the rock 195 feet above the level of Snake River, yielded a flow of 864 second-feet. The horizontal beds of lava, which form the surface rim rock, are in part responsible for this tremendous flow of water. They were deposited during the Tertiary and Quaternary periods, and are so vesicular and so broken with joint planes that they absorb and transmit

[1] A second-foot, that is, 1 cubic foot a second, is equivalent to a flow of 448 gallons a minute or 645,120 gallons a day.



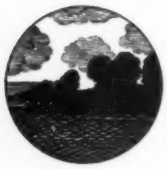
Bermuda Photo Service

A GORGEOUS SETTING OF STALACTITES IN A BERMUDA CAVE

The Bermuda caves were formed when the islands stood at a higher level. 'Due, however, to a subsidence of the islands, perhaps 80 to 100 feet during the Pleistocene or Glacial Period, the lower levels of the caves have been flooded with sea water

water freely. The water comes from the heavy rains and snows which fall upon the extensive lava plateau and bordering mountains during the winter season. The great body of ground water is obviously held up by an underlying impermeable formation, and it is not improbable that these dense rocks constitute a former land surface, and that the principal underground streams, which supply the springs, follow down the valleys of this ancient surface.

In conclusion it may be stated that the amount of ground water within the crust of the earth is enormous, that it occupies great depths, perhaps six miles, and has been accumulating for untold ages. The quantity has been estimated tc be nearly one-third the total volume of the oceanic waters. This great mass of water percolates slowly through the porous and jointed rocks to form great systems of underground drainage, and to take part in geologic work of profound importance. Where geologic conditions cause these waters to converge, subterranean streams are formed, but they are as a rule small; large underground rivers are rare and, when discovered, they have attracted wide attention. Underground streams are usually short and the volume of water present is dependent upon the size of the catchment area, the amount of precipitation, and whether the subterranean drainage system is in a youthful or mature stage of development. The rate of discharge of such rivers, especially in limestone regions, is also dependent upon whether the cavernous passageways have subsided, forming storage reservoirs, or whether they have remained stationary with reference to sea level since their formation, or whether they have been elevated, permitting the acidulated waters to etch out new channels at lower levels. The subject is a fascinating one, for it permits a look into Nature's great underground laboratory where waters, charged with all sorts of mineral substances, are circulating in many directions, and performing chemical work of great geologic and economic importance.



HOW CENTRAL ASIA TRAVELS

The Ancient Methods of Transportation That Are Still in Use in the Heart of the Greatest of Continents

By WILLIAM J. MORDEN

Field Associate in Mammalogy, American Museum

FROM the Karakoram Mountains, which mark, roughly, the northern limits of India to the Trans-Siberian Railroad, is about the same distance as from Corpus Christi, Texas, to Winnipeg, Canada. From the Sea of Aral on the west to the eastern limits of the Gobi Desert the distance is about the same as from San Francisco to New York. That portion of the greatest of continents is, then, somewhat larger than the United States, yet within this entire expanse, which is made up of mountains and deserts, plains, oases, and fertile valleys, transportation facilities, in the modern sense, do not exist. Millions of inhabitants obtain their meager livelihoods in hundreds of different ways. Scores of different tribes inhabit innumerable wide-flung districts. Some of the greatest migrations in history and some of the most destructive hordes of warriors have utilized the trails and roads of that enormous land, yet, without exception, migrants, warriors, and tradesmen, herdsmen, hunters, and explorers have been forced to move across mountains and plains and valleys without a single one of the numerous modern methods of transportation without which Europe and America could never have attained their present predominance in world affairs.

Since before the dawn of history this huge section of the interior of Asia has made almost no advances whatever in its methods of transportation. With the taming of yaks and camels and horses their advances in this field seem almost to have ended. Since taking that important step, only a few halting advances have been added, and it is probable that the armies of Jenghiz Kahn, of Ogdai, and Kublai Kahn, and Tamerlane were at least as well equipped, so far as their transportation was concerned, as are the present-day dwellers in the heart of Asia.

During 1926, as leader of the Morden-Clark Asiatic Expedition, I had the opportunity of traversing much of this great area—of living close to the people, and of being able to observe the methods of transportation in common use through thousands of miles of this sparsely settled land. It was not, of course, our purpose to

CENTRAL ASIA

Showing the route traversed by the Morden-Clark Asiatic Expedition from Kashmir to the Trans-Siberian Railroad. The transportation methods of this enormous land are described in the accompanying article

study transportation, but because we had to travel so far, and were forced throughout to utilize the local means of transport, we naturally became familiar with practically all of the methods in present-day use.

The route northward from the Vale of Kashmir into Central Asia leads abruptly upward into and across the Himalaya and through the territories of Gilgit and Hunza, the latter of which lies amid the mighty peaks of the Karakoram Range. During the short summer season pack ponies are the usual method of transport along this route, which is known as the Gilgit Road, though it is but a tortuous military trail that is not adapted for wheeled transport. Owing to the fact, however, that the trail winds among the mountains and over several passes which lie high and exposed to the heavy winter snows, those attempting the journey before the snows have disappeared from the trail must depend for the transport of kit and supplies upon coolies locally obtained.

These men are difficult to hire, owing to the sparseness of the population in the districts traversed and the necessity for every available man to labor in the stony fields at every opportunity. Furthermore, it is not possible, as it is in Africa, to hire men for more than a march or two at a time. The result is that the traveler is forced to hire new coolies at least every day or two, and sometimes he must do so more than once a day. Nor is it possible to obtain any coolies at all without the assistance of the government, for only when the traveler is accompanied by a representative of the local official, who has the power to requisition men from the villages along the route, is it possible to hire them at all. The rates of hire are fixed by the government and average about one cent a mile. More than that, the men feed themselves, carrying in addition to their load a little bag of grain or meal.

One of my most vivid recollections of Himalayan travel is of a long file of gray-

clad figures toiling upward through the deep drifts of the Burzil Pass in the dim half-light of early dawn, with snow-clad peaks showing ghostlike against the gray sky. A bitter wind howling down the pass twisted wraiths of stinging snow into the faces of the sixty struggling men, while their heavy packs, carried, as is usual with all hill people, upon their backs, forced them to bend almost double to negotiate the ascent. Though we had kept our loads at somewhat less than the sixty pounds set as a maximum by the government, a couple of the coolies were completely exhausted by the time the summit was reached, but they both, after a short rest in the snow, gamely arose and carried on to the rest house five or six miles down the farther side.

The coolies of Kashmir carry T-shaped sticks which they use as staffs and also as supports for their packs when making short halts. This ingenious device obviates the necessity for sitting down during short pauses for rest, with the attendant difficulty of again rising to the feet, for the staff can readily be thrust under the load, thus relieving the bearer of most of the weight. For the longer halts, of course, the men drop into the snow and struggle out of their harness. The coolies who do a considerable amount of packing have frames of light wood with the pack ropes already in place. On these frames the packs are placed and lashed fast, the whole arrangement enabling them to handle unwieldy loads with greater ease.

Along the route of our journey of 1926 it was only in the Himalaya and the Karakoram ranges that we found coolie transport in common use, for in the mountainous regions of the Thian Shan and the Altai, animal transport was almost invariably feasible. So far as I know,

KASHMIRI COOLIES ON THE BURZIL TRAIL

These men, loaded with packs weighing up to sixty pounds, are employed at the rate of one half anna—about one cent—a mile. Occasionally one of them travels barefoot, except for rice-straw sandals, and for short rests they support their packs on the T-shaped staffs they universally carry. "Marches" average from ten to fifteen miles

those regions through which we first passed are the only ones in Asia where coolie transport is general.

While it is true that throughout Central Asia coolie transport is not common, all the other means of transportation are certainly primitive enough. The use of pack animals is most widespread, and of the different animals used, ponies, horses, camels, and yaks, with a sprinkling of donkeys, form the major portion. Our first experience with Central Asiatic pack animals was with the little Himalayan ponies, for which we had been warned to provide especially short cinches on our army saddles. It was fortunate that we had done so, for the girth of one of these sturdy little creatures seems to be little more than half that of an average American cavalry mount. Notwithstanding their diminutive size, and their apparent lack of strength, these little beasts carried our kit and ourselves for marches of ten to fifteen miles over rough mountain trails in a manner that surprised us. At first it seemed like cruelty to animals for us to bestride the shaggy little fellows while they struggled along uphill and down, forcing us, now and then, to lift our feet to avoid contact with the bowlders that were in many places thickly strewn in the trail. Before we reached the Pamirs and transferred to the backs of yaks, however, we had come to have a very great deal of respect for the strength and ability of the Himalayan pony.

In the Thian Shan and in other parts of Central Asia, horses somewhat larger than the ponies of the Himalayan districts are common. Several months after leaving the Himalaya our pack train consisted of about thirty Turki horses which, after carrying us through the Thian Shan on a journey of several weeks, ended that portion of our trek by a march of fifty-five miles, which they made in about

THE STEED OF THE PAMIRS IS THE YAK

This animal, while not native to the Pamirs, is widely used there by the Kirghiz who inhabit that inhospitable land. James L. Clark is shown here with his mount in one of the higher valleys

WILLIAM J. MORDEN ON A HIMALAYAN "TAT"

The sturdy little ponies, bred in the mountains and accustomed to the steep and rocky trails, are surprisingly useful. So small are they that the regular army saddles that formed a part of the equipment of the Morden-Clark Expedition had to be specially prepared with short cinches. Yet, despite their limited size, these animals carried their riders for fifteen miles or more a day over the mountain trails without noticeable fatigue

twenty-four hours, including a rest of hardly more than two hours on the way.

If only because they are not to be found outside the higher districts of Central Asia, yaks are likely to attract more than their fair share of attention. This does not mean, however, that yaks do not have characteristics of their own that are interesting—and sometimes maddening. Yaks, of course, are not greatly unlike shaggy, hump-backed cattle, relatives of which they are. But just as other families show wide ranges of temperament, so does this, for certainly no self-respecting cattle ever display such extremes of "mulishness" as yaks are likely to develop upon the slightest provocation. Upon mounting one of these beasts the rider is likely to find that his steed has decided to lie down, though usually it can be persuaded to rise again with a proper application of the stick which is an absolutely essential part of the rider's equipment. Once under way, continued application of the stick is more cr less necessary, although when the creature decides to stop, no amount of moral or physical urging will have the slightest effect. On one occasion we had a yak that decided he had gone far enough, and so stopped suddenly in the trail. The combined efforts of several men were entirely unavailing, so, after half an hour, the saddle was removed, and the animal was left to his own meditations. Three days later we passed that way again, and found our yak within a dozen feet of where we had left him. Plenty of signs showed us that he had not wandered farther than that in all the time he had been left alone, but now, having outgrown his sulks, it permitted us to saddle him once more and to take him

ON THE MUZART GLACIER IN THE THIAN SHAN MOUNTAINS
Though it is impossible to construct a permanent road over the constantly changing surface of such a glacier as this, much of the trade between Kashgaria, south of the Thian Shan, and Dzungaria, which lies to the north, must pass this way. A large annual toll of pack animals is taken by this glacier, and the trail is lined with skeletons of the unfortunate beasts

with us along the trail.

Now and then, on some steep and difficult trail, one's yak will suddenly decide to go no farther, which in itself would not be so bad were it not for a habit that they sometimes have of reversing their direction suddenly, and backing abruptly down hill. This may be partly humorous, or it may seem like a near approach to tragedy, especially if the edge of some high cliff is in one's immediate rear.

With all their failings, however, yaks make travel possible in districts where great elevations, steep slopes, and the lack of forage prevent the utilization of other animals. Native as these creatures are to Tibet and parts of the Himalaya, they are acclimated to rarefied air and great cold, and are raised in numbers by the natives of the Pamirs and some parts of Mongolia. Only in Tibet and the Pamirs, however, have I seen them in common use.

The only other important beast of burden in Central Asia, donkeys excepted, is the two-humped, or Bactrian, camel. These huge, ungainly beasts are, of course, related to the lighter African dromedaries, but the differences between them are as great as are those between yaks and cattle. The African dromedary is not an animal noted for his good nature, but he is considerably outdone by his Asiatic cousin, whose disposition causes him to scream and groan at the slightest provocation, to kick and bite with very little cause indeed, and to show such a fearsome set of teeth upon being approached, as might make the bravest quail. It is not generally understood that an Asiatic camel can display a tremendous pair of canine teeth that would do credit to a full-grown lion, and though the camel drivers appear to pay little attention to the baring of these fangs, I have been told that the bite of a camel may easily prove to be serious because of the likelihood of blood poisoning.

The Bactrian camel is a cold-weather

animal, and travels best at low temperatures. During our travel by camel caravan in Dzungaria and Mongolia, it was noticeable that the speed of these animals was greater after the chill of night had fallen. During most of this journey the temperature was never above freezing, but the camels traveled best when it was near zero. During the winter they are protected by an amazingly thick coat of hair which forms an efficient armor against the snow and cold.

Mongolian camel-drivers commonly load these beasts with four or five hundred pounds of freight, and under such loads the camels of a caravan are likely to average from two to two and a half miles an hour. Twenty-five miles is an exceptionally long day's march, but no other animal could possibly perform the work a camel is called upon to do, under the conditions he is often forced to face. On muddy or icy trails camels are at a decided disadvantage, it is true, for their padded feet can obtain little traction, and their long legs, when they slip, often shoot out in the most surprising manner. On dry ground, however, this difficulty is overcome, and the camel is admirably adapted for travel in much of the desert areas of Central Asia.

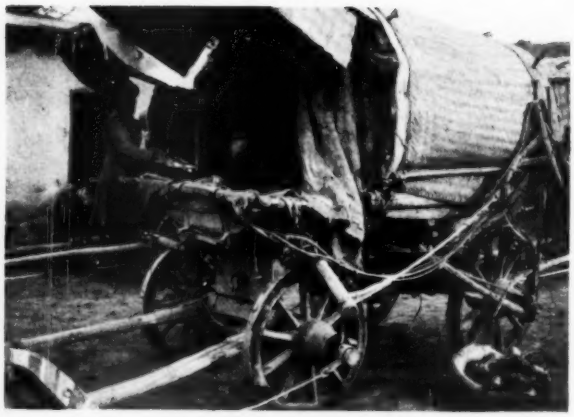
Perhaps the most striking recollection that I have of Central Asiatic travel is of the night marches of our camel caravan. I can close my eyes and see the dim shapes of our thirty camels looming huge and weird against the background of snow that lay gray in the faint starlight. I can hear the camel bells clanging and booming in the darkness, their irregular sounds punctuated, now and then, by the shouts of the caravan men—shouts that end eerily in high falsetto notes.

KALMUCK HUNTERS OF THE THIAN SHAN MOUNTED ON BULLOCKS

Though the Kalmucks raise horses, they often ride bullocks when they are on hunting trips. What appears as a fork on the back of the figure at the right is really a ponderous muzzle-loader with a forked rest that is hinged to the barrel near the muzzle. This rest is an invariable addition to practically all native guns

AN ARABA

(*Above.*) The wheel horse maintains the balance of the load and steers it. The rope traces of the leading horses pass through large rings on the shafts and are attached beneath the cart



A TELEGA

(*Right.*) These light carts, the gauge of which is about three feet, are used for rapid transport in Dzungaria

A CENTRAL ASIAN TRAVOIS

(*Below.*) Similar, except for its upright frame, to the travois of the American Plains Indians, this conveyance is occasionally used in the Thian Shan

A TROIKA

(*Above.*) The Morden-Clark Expedition covered 250 miles in eight days by means of this three-horsed Russian vehicle

A BULLOCK CART

(*Left.*) Many of these crude vehicles are used in Dzungaria for the transport of salt and grain

THE AXLE OF A MAPA

(*Below.*) This cart is similar in construction to the araba but is lighter and, therefore, faster. The gauge of both these vehicles is about eight feet, but due to the fact that the wear on the wooden axles must be taken up by cutting new slots for the pin that holds the wheel on, the gauge of no two vehicles is the same

A BRIDGE IN THE THIAN SHAN
These flimsy structures must be crossed carefully, for any great concentration of weight or any considerable vibration is liable to cause their collapse

There was a strange and overpowering monotony of motion and of sound that made it almost impossible for one to stay awake in one's saddle, and many times I have straightened up only to find that sleep had almost overcome me. The camel men, long accustomed to such travel, usually draped themselves over the diminutive forms of their patient little donkeys, and frankly went to sleep, while Clark and I tried to keep the trail, or failing that, attempted to steer a course by the stars or by our compasses.

It must not be supposed, of course, that pack animals are the only means of transportation in Central Asia. It is true that none of this vast district is traversed by any modern conveyance, but in the less mountainous regions of Kashgaria, Dzungaria, Northern Mongolia, and Siberia, carts of various kinds are widely used. Two-wheeled carts are probably the most common, and in Kashgaria these take the form of the huge, unwieldy *arabas*, although the lighter *mapas* are used in the same district for more rapid travel.

The simplest of all these vehicles are the bullock carts so commonly used for the transportation of bulk freight in Dzungaria. One of these consists of nothing more than two wheels connected by an axle which revolves with the wheels. Upon the axle the body of the cart rests, being held in place merely by a couple of simple pegs on each side, between which the axle revolves. A single bullock is generally the motive power, and the driver usually sits on one of the shafts. In the case of a train of such carts, one driver is sometimes in charge of several of the creaking, groaning, heavily laden affairs. The wheels are of the crudest possible construction, as, of course, is everything else about the vehicle.

By comparison with these carts, the

arabas, which are very widely used, are really quite refined. They are two-wheeled also, but their wheels are mounted on journals, and rotate about the axles, upon which the bodies of the carts are firmly set. The wheels are not the crudely constructed affairs of the ox-carts, but are usually well made, being built up of spokes and felloes almost exactly as are the wheels of wagons used in America. The wheels are, however, very high, often measuring as many as six feet in diameter, and the gauge of these vehicles is, to an occidental, very wide indeed, being about eight feet.

A wheel horse is placed between the shafts of these carts, and is generally flanked by two other horses, outside the shafts. Occasionally one or two horses are harnessed ahead in tandem, although no very definite system seems to be adhered to.

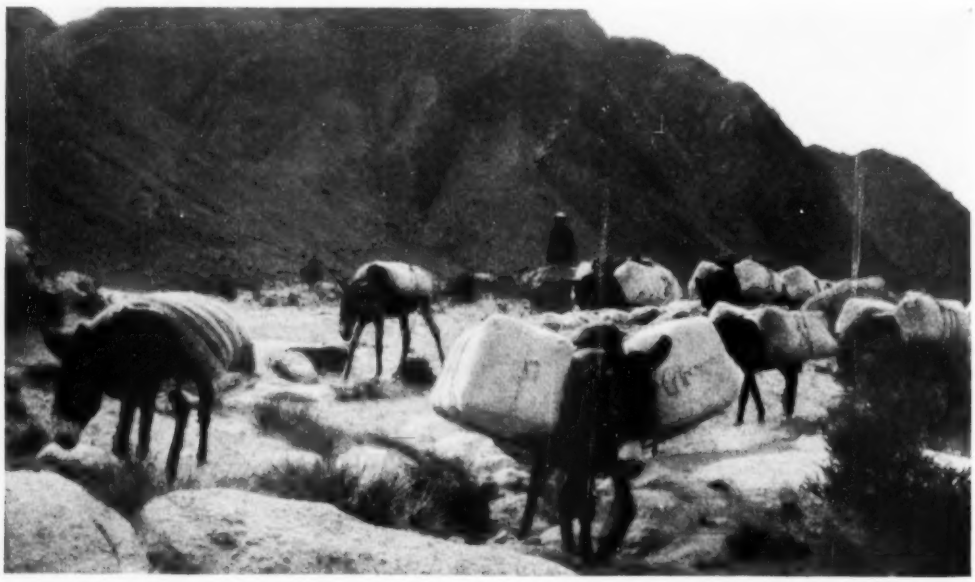
Related to these huge carts are the smaller *mapas* which, with smaller wheels and lighter construction, are called upon for faster travel. Speed, however, in the modern meaning of the word, is not to be thought of in connection with any of the vehicles of Central Asia. If the going is good, and the horses are in the best of condition, lightly loaded *mapas* can sometimes cover as many as thirty miles in a day. The average day's travel with such a cart, however, is less, and an *araba* could never be made to lumber along at any such breath-taking rate.

If one is bent on speed, one must wait until he arrives in Dzungaria, where he can obtain a *telega*. These are four-wheeled conveyances, with a gauge of about three feet, and are drawn by three horses hitched abreast. They are very lightly constructed, and one is apt to imagine, from a cursory examination,

A FERRY ON THE AKSU RIVER

Two mapas, eight horses, and about forty men with their equipment, can be crowded aboard such a scow, which is pushed off into the current and, with the assistance of two planks at one end and a sweep at the other, eventually reaches the opposite shore about half a mile downstream

that they will fall apart at the very first bump. Thongs, pieces of wire, frayed rope, and an amazing variety of other connections are all that can be depended upon to hold these vehicles together. Yet despite appearances, they are surprisingly sturdy, and to my amazement those that we obtained made the 156 miles from Urumchi to Kuchengtze in exactly three days without a change of horses—an amazing feat for any Central Asiatic means of communication.



BURDEN BEARERS IN ASIA AS ELSEWHERE

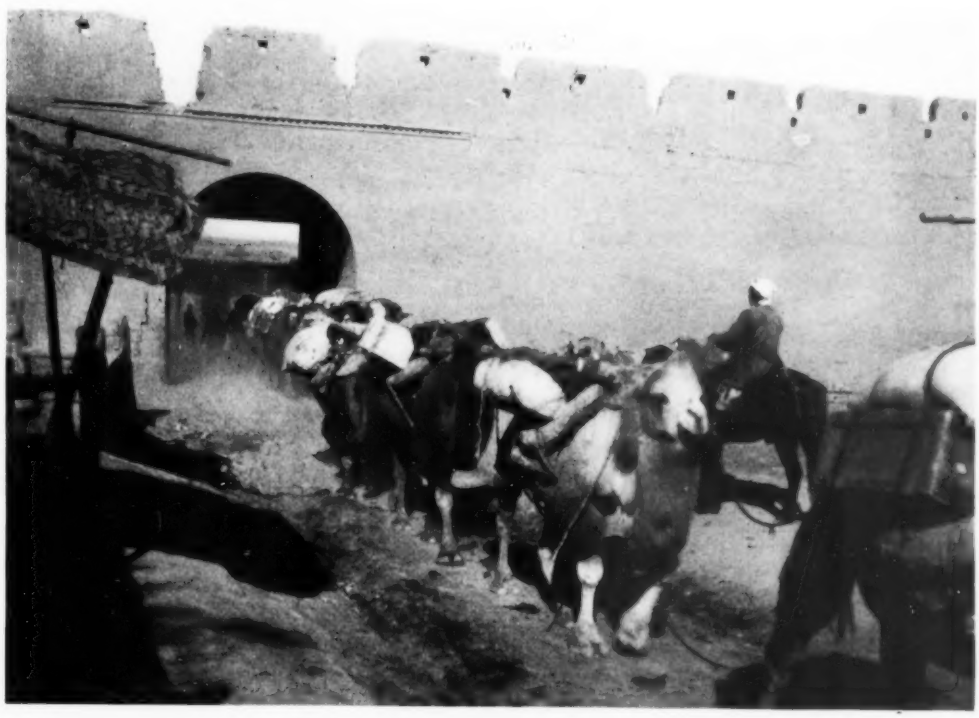
Donkeys are widely used in Kashgaria and the Thian Shan. They even accompany camel caravans across the Gobi Desert, although there they are ridden by the camel men

There are, of course, other methods of travel in that vast district that makes up most of the interior of Asia, but these I have named are, without doubt, the most important—unless one adds the sleighs, so commonly used in Siberia during the winter. With such primitive means of transport, it is only natural that Central Asia should remain what it is—one of the most backward of all the large divisions of the earth. Nor is it possible for a district so poor to build the roads necessary for an improvement of the situation. The richest of nations would hesitate to expend the sums necessary to build roads in so difficult a land. The time undoubtedly will come, of course, when better means of communication will be available. Already a very few motor cars have found their way across deserts and mountains to the interior of this land, but so few are they, and so worn by the vicissitudes of the long journey, that they are not to be taken seriously. Roads can hardly be said to exist. Paving is unknown, and it is possible that airplane travel may be practical before motor cars can make a very great deal of headway. Such exceptional journeys by motor car as those made by the Central Asiatic Expeditions under Roy Chapman Andrews are proof that the difficulties of the land can be overcome, but only by the most careful preparations are such journeys made possible.

Central Asia is a distant land, difficult

A TRADING CARAVAN IN THE YULDUZ VALLEY

The camel of Central Asia is the Bactrian—a two-humped animal. It is a cold-weather beast, and travels best when the thermometer is below freezing. Burdens from 400 to 600 hundred pounds are usual



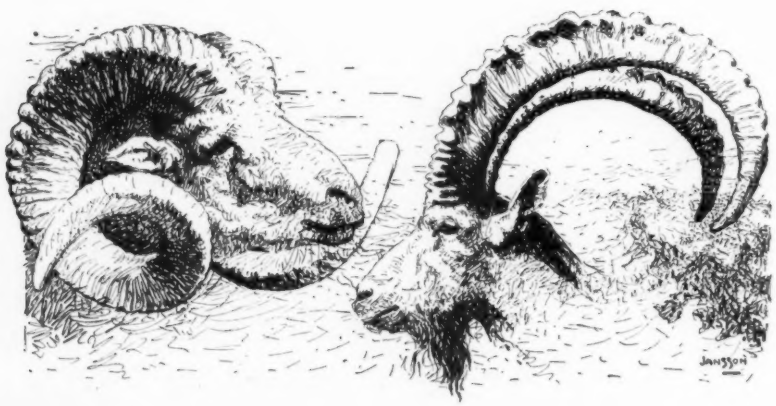
THE MORDEN-CLARK EXPEDITION LEAVING KUCHENGTZE

Thirty camels carried the equipment of the American Museum party about 600 miles to Kobdo, in Mongolia. It was while traveling with these animals that Mr. Morden and Mr. Clark were captured and tortured by Mongol soldiers of the Altai Mountains

CROSSING THE MINTAKA PASS

Yaks are widely used as riding and pack animals. Their hair makes excellent felt coverings for the movable dwellings of the natives, and the milk from the yaks is an important item of food. They are invaluable in a country where horses cannot be used because of the extreme altitude and the almost total lack of forage for much of the year

of entry. Little known and not widely traveled, it offers a fertile field in which the scientist can study widely, but until the modern world has made some impress upon it—until transportation in the modern sense has been introduced—all that vast district of mountains, deserts, and fertile valleys is likely to remain the distant, difficult land that it has always been—the land of mystery in which the world as it existed a thousand years ago is with us still.



SYMMETRY IN NATURE

Perfection of Design as Shown in the Mineral, Vegetable, and Animal Worlds

By HERBERT P. WHITLOCK

Curator of Mineralogy, American Museum

With Thirteen Figures by the Author

IT is one of the oustanding features of our modern life that we know many things without being conscious that we know them. We subconsciously observe facts and phenomena without realizing their significance, and we marvel at and admire that which excites our wonder and our admiration without stopping to orient our experiences or to analyze our impressions. This general impression of satisfaction which we receive from the perfection of form in the natural objects about us, makes us overlook how much this perfection of form is due to repetition of design. To cite a very familiar example: We are pleasurably impressed with the pattern of a certain design in wall paper, so much so, in fact, that we may have it put on the walls of our bedroom. However, it is not until under stress of a day of sickness or a morning of wakefulness we spend hours gazing at the wall, that we discover how many times and in what respects the pattern repeats itself.

Photograph by Clyde Fisher

PASTURE ROSE

The five petals of this blossom show five-fold repetition, or five-fold symmetry

This repetition is the basis of what is known as symmetry; as popularly conceived it may be expressed as the similarity of parts on opposite sides of a dividing line. A maple leaf is a good example of such symmetry with respect to a line, or, considering something with a solid rather than flat dimension, the outside aspect of our bodies may be used as an illustration. But in this case the line corresponding to the one that symmetrically divides the maple leaf must now be considered as a plane. The symmetry that repeats parts and members on opposite sides (to the right and left) of an imaginary plane dividing the object through the middle, is so universal among the higher forms of animals that it has become our standard for harmony and balance.

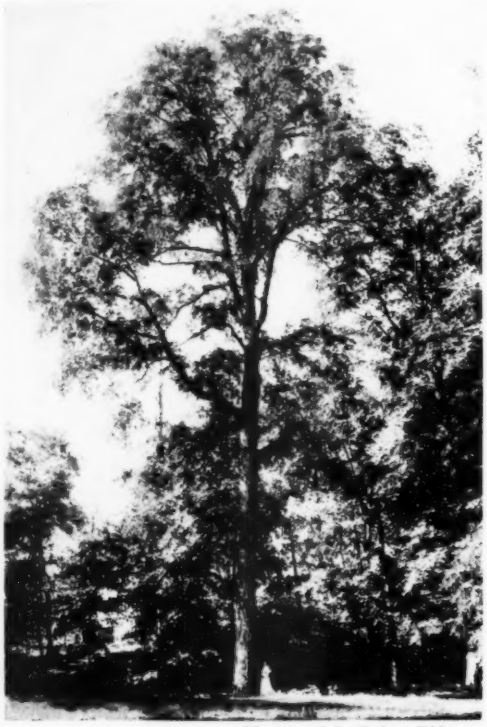
But the regular repetition of parts, which is symmetry in its broader sense, takes on a much wider aspect when we turn to the consideration of the lower forms of animals, and especially when we come to examine the plants. Everyone who has spent any time on a seabeach at low tide knows the different varieties of starfish with their five arms radiating from a center, or the sea urchins whose thin, spiny shells show designs repeated five times like the symmetry of a star from the blue field of our flag. Now when we examine these objects—the starfish, the sea urchin, and the five-pointed star—

with regard to the repetition of their parts, we find that for each of them there is a central point about which it is possible to rotate the object until it appears in exactly the same aspect as in its original position, and that, on continuing the rotation through a complete circle back to the starting point, the object will appear, in all, five times in its original aspect. The central point (in solid objects, a central line or axis) about which we have revolved the object is a point of five-fold symmetry. Objects exhibiting five-fold symmetry—the symmetry of the starfish and the sea urchin—are extremely common in the organic world, although as we shall presently see, this kind of symmetry is entirely lacking in crystals, which constitute the overwhelming range of symmetrical objects in the inorganic realms of nature. To cite a few very familiar examples of five-fold symmetry: We have such common flowers as the apple blossom, buttercup, morning glory, mountain laurel, marsh pink, the single flowers of common milkweed and of phlox, and a host of others.

All of these have the symmetry of the five-pointed star at the top of page 163. That is, besides a five-fold repetition about the axis of five-fold symmetry (shaded in solid black) they are also symmetrical to the right and left of the lines marked I, II, III, IV, and V.

A maple leaf symmetrical to a line

Now we can readily assume a pattern or an object which has a five-fold symmetry—one that appears five times in a certain aspect on revolving it through a circle, and yet cannot be halved into symmetrical right and left pieces like the five-pointed star. If we were to attempt to construct such a pattern, we might produce something like that at the bottom of page 163, which is just as much referable to a five-fold axes of symmetry as is the star, but lacks some of the elements of symmetry of the latter.

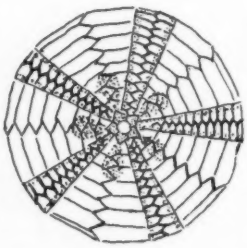


Photograph by Robert Ridgway

A SUGAR MAPLE

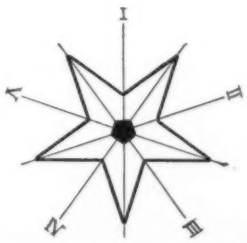
Each of the thousands of leaves of this tree shows the symmetry of the drawing above

Having mastered what is meant by five-fold symmetry, let us look for other expressions of symmetry, based on numbers which are greater or less than five, but conforming to the same rule of repetition. The winged seeds of the sycamore maple give us an example of two-fold symmetry, because, holding them by the stems, we



The five-fold symmetry of a sea urchin

can twist them about until their original aspect is repeated in one complete twist. This is quite different from the symmetry of our bodies, which would necessarily have our heads repeated where our feet are, to fulfill the repetition requirement of this two-fold, or binary, symmetry.



Five-fold symmetry and also lines of symmetry

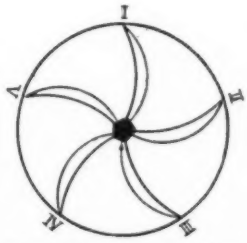
Similarly, we can find expressions of three-fold or trigonal symmetry in the very common three-leaved clover (not the unusual four-leaved one), and in such wood and marsh flowers as trillium or wake-robin, page 165, and in the blue flag or iris, page 166.

For an object of four-fold or quaternary symmetry, an open and empty chestnut burr suggests itself, although that beautifully conventional blossom, the dogwood, might be thought of here. We also have the six-fold symmetry of the wood lily and the dog berry. Then there are examples of symmetry in organic nature based on numbers higher than six, although these are relatively rare. When we consider examples of eight-fold and nine-fold symmetry, nearly always we find that these are only somewhat more complete four-fold and three-fold expressions respectively.

Photograph by E. M. Kittredge

DOGWOOD IN BLOOM

Every blossom on this little tree has four petals repeated in a beautiful design of four-fold symmetry



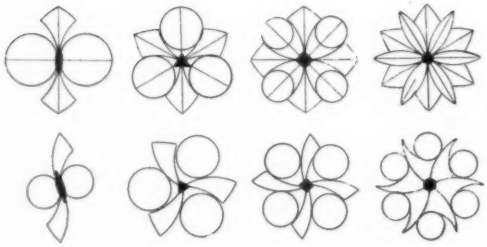
Five-fold symmetry but no lines of symmetry

In order to clarify our ideas respecting two-fold, three-fold, four-fold, and six-fold symmetry, let us study the group of geometric designs shown on page 164, which might be characterized as wall paper, linoleum, or fresco designs.

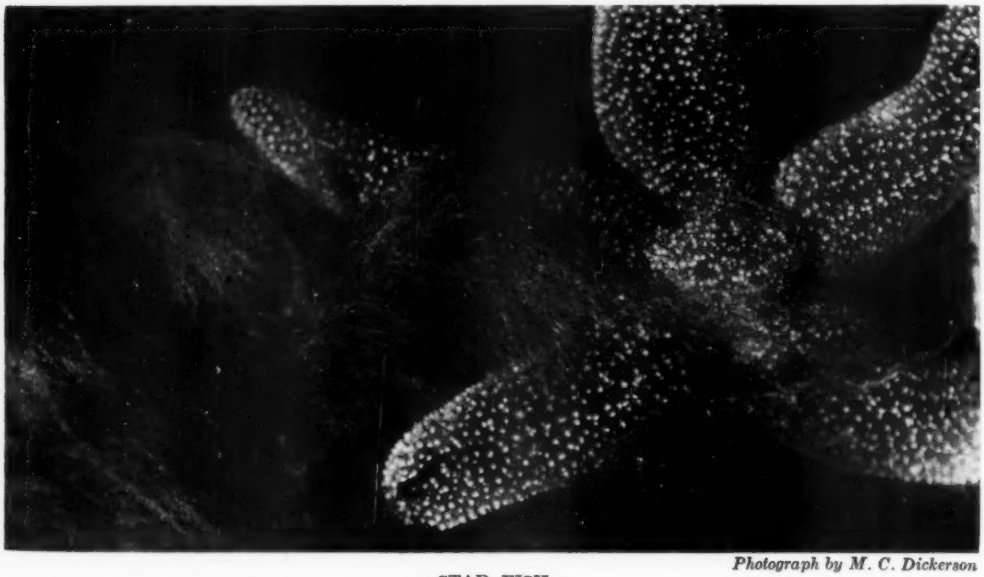
To verify the number of repetitions which determine the symmetry it is necessary only to rotate the page through one half, one third, one quarter, etc. turns to arrive at a repetition of the original aspect, in the instances of two-fold, three-fold, and four-fold symmetry respectively. The figures in the upper row are also symmetrical to two, three, four, and six lines of symmetry as indicated by the straight lines, but these lines of symmetry are entirely lacking in the corresponding figures in the lower row. In this way we have demonstrated the very important fact that symmetry, whether it be two-fold, three-fold, four-fold, or six-fold, does not necessarily include a line or lines of symmetry. Extending this principle to the symmetry of solid figures, *an axis of symmetry may or may not include one or more planes of symmetry.*

We have seen to what an extent the forms of plant life

illustrate symmetry in nature. It was through an appreciation of this perfection of orderly arrangement in plant forms that Réné Just Haüy was led to seek for and finally to find that ultimate perfection of symmetry, which in crystalization lies at the base of the great inorganic world. The Abbé Haüy, familiar as he was with the symmetries of plant forms, argued that such harmony of shape must also exist in the realm of inorganic nature. Now, between the symmetry of organic forms and that which characterizes crystals, there exists this comprehensive difference: In the shapes of the plants and of the lower animals, we meet with curved or rounded parts disposed in obviously symmetrical designs, whereas in crystals we find angular solids whose surfaces are composed of flat planes, and it is in the disposition of these planes with relation to one another that we must look for that symmetry of design which, although not always as obvious as that of a rose or a clover leaf, is far more satisfying to our reason because it is mathematically precise. In other words, it is a symmetry of angles, and of angles which are exact to the limits of our capacity for measuring them. Furthermore, in these solid angular forms we find the



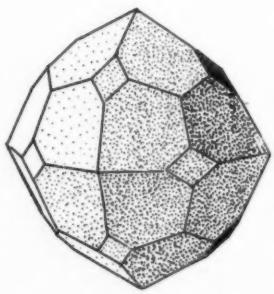
A group of conventional figures showing two-fold, three-fold, four-fold, and six-fold symmetry. The upper row is also symmetrical to the straight lines shown. The lower row has no *lines* of symmetry



Photograph by M. C. Dickerson

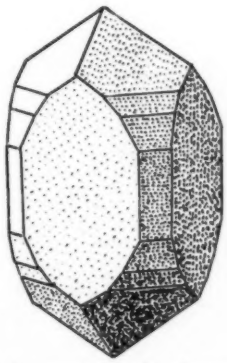
STAR FISH

Its five arms, exactly alike, show five-fold symmetry, the common symmetry of certain lower forms



A crystal of garnet drawn in perspective

highest expression of symmetry, that is, symmetry that is dependent on symmetry. Take, for example, a very common crystal, one that is quite characteristic of the mineral garnet and which is drawn in a sort of conventionalized perspective on page 164. If we were to handle this little angular solid, turning it this way and that, we would soon find that we could hold it in such a way that it would look like the first of the three drawings grouped at the bottom of page 165. Then reversing it and turning it to the right and left we would discover five more positions in which it presented the same aspect. But since these six positions are placed in three opposite pairs, it follows that we really have found three axes,



A crystal of zircon drawn in perspective

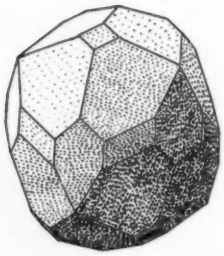
and the disposition of the edges around them tells us they are axes of four-fold symmetry. Looking again at our garnet crystal, we find an axis of three-fold symmetry, as illustrated in the central drawing, and counting up the number of times this aspect of the crystal can be presented to our eye, we find that it has four such three-fold axes. And even now we have not reached the limit of complexity in the symmetry of this amazing little fragment of Mother Earth. It will still show us six axes of two-fold symmetry similar to that in the third drawing of the same series, not to mention nine planes of symmetry. Nor is this in any sense a unique example. There are hundreds of crystals of different designs (to use a popular term)

Photograph by Clyde Fisher

TRILLIUM IN FRUIT

Three-fold symmetry characterizes these triangular stars of the woods

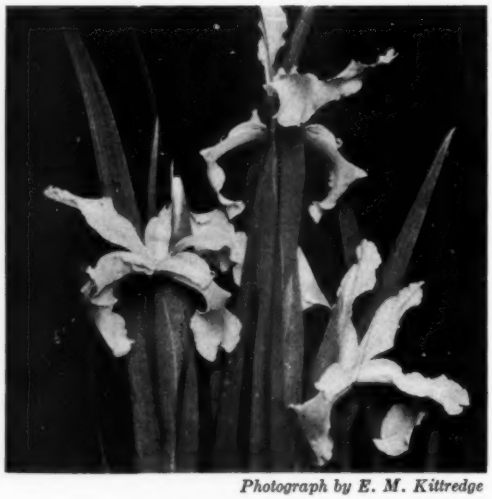
A crystal of garnet viewed from various directions to show axes of four-fold, three-fold, and two-fold symmetry



A crystal of calcite drawn in perspective

scattered throughout the mineral kingdom, all of which are just as symmetrical as the one we have chosen.

But let us turn to a crystal whose symmetry is expressed in a different way. The drawing at the top of page 165 is of a crystal of zircon, a silicate of zirconium. We see at once that this crystal is not nearly so perfect in symmetry as the garnet crystal of our last example, and consequently it is rather easier to analyze. Looking down on one end of it, or to speak technically, on its termination, we get the view shown in the first drawing of this series at the bottom of page 166, which shows us that the crystal has one axis of four-fold symmetry; the planes forming the opposite termination, which is the other end of the four-fold axis of symmetry, are grouped in exactly the same way as those shown in this drawing. Also, there are four views on different sides like the second drawing, meaning two axes of two-fold symmetry, and four more views like the third drawing, giving two additional two-fold axes of symmetry. As to planes of symmetry, we can divide our crystal into right and left halves longitudinally through each axis of two-fold symmetry, making four planes (looking again at the drawing at the top of page 165, makes this a little plainer), and of course we can also divide it symmetrically into an upper and a lower half, making one more plane of symmetry. So we have as the symmetry of this zircon crystal, one axis of four-fold symmetry, four axes of two-fold symmetry and five planes of symmetry one of which we call a principal plane and four of which we call secondary planes.

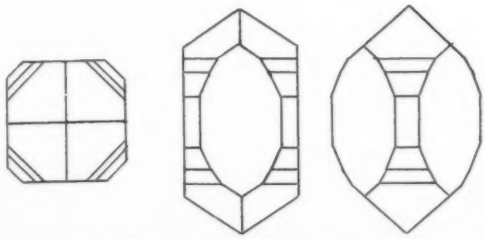


Photograph by E. M. Kittredge

IRIS BLOOMS

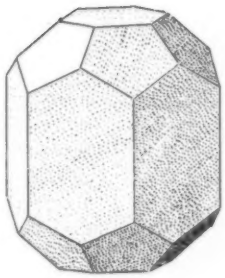
When the French conventionalized this flower in the *fleur-de-lis*, they emphasized its three-fold symmetry into a symbol

Now let us take another example, the crystal of calcite, a perspective drawing of which is shown at the top of this page. Searching this crystal for an axis of a higher grade of symmetry, we will profit by our study of the zircon crystal, and look down on one end of it, finding the view shown in the first of the pair of drawings on page 167. We have here an axis of three-fold symmetry, but one of a slightly different type from the axis of four-fold symmetry of the zircon crys-



Top and side views of the zircon crystal pictured on page 165, showing four- and two-fold symmetry

tal. It is true that the two ends of the axis terminate in the same combination of planes, disposed around the axis in the same way, but they are not as in the last example, directly one over the other; the edges of the upper termination are shown in full lines, and those of the lower in dotted lines. The effect is as though the one termination had been turned in reverse position to the other. It is also possible to find three axes of two-fold symmetry, giving six aspects of the crystal similar to the second of the two drawings at the bottom of page 167, and, as we are by this time prepared to expect, three planes of symmetry, each including the three-fold axis and one two-fold axis.

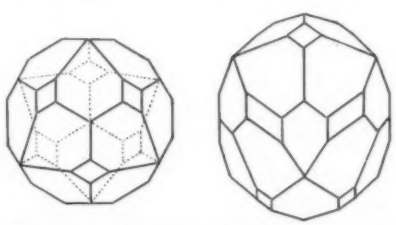


A crystal of beryl drawn in perspective

Photograph by E. M. Kittredge

A SPRAY OF MOUNTAIN LAUREL
This is one of the most perfect examples of five-fold symmetry among flowers

In the foregoing examples we have encountered planes of symmetry and axes of two-fold, three-fold, and four-fold symmetry. There is still another element of symmetry present among crystals that should be cited —an axis of six-fold symmetry. In the sketch at the top of this page is shown a perspective drawing of a crystal of beryl which has six-fold or hexagonal symmetry. It will be seen when we consider the three aspects of this crystal, shown in the three associated drawings on page 168, that here we have a combination of symmetry elements somewhat comparable to the zircon crystal of our second example. The difference is imposed by the axis of six-fold symmetry which in the first of the series of three drawings on page 168 takes the place of an axis of four-fold symmetry in the zircon crystal, and which necessitates six two-fold axes instead of four, and six longitudinal planes of symmetry as compared to four for the zircon crystal.



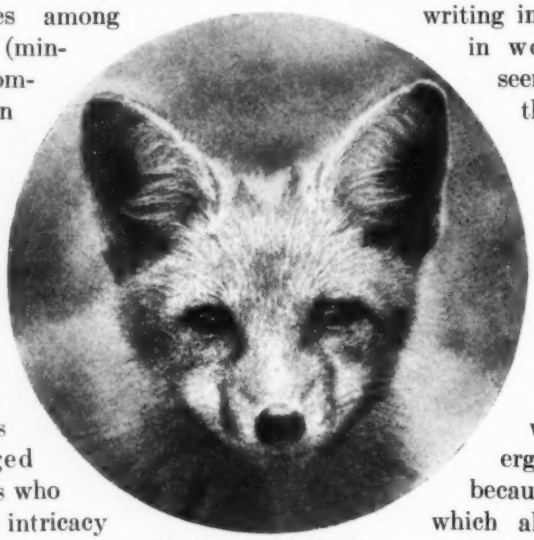
Top and side view of the calcite crystal pictured on page 166, showing three-fold and two-fold axes of symmetry

These examples, which have been chosen somewhat casually from among innumerable crystals, give us some faint conception of the orderly complexity of symmetry in this realm of nature. Early in the history of the science of crystallography there was deduced, on a purely mathematical basis, the possibility of the existence of thirty-two types or classes of crystal symmetry, involving the symmetry elements with which we have been

dealing. Up to the present time all of these theoretical classes of symmetry with one exception have been found to have representatives among natural compounds (minerals) or artificial compounds (produced in the laboratory) or among both.

The recorded drawings of crystals of minerals alone amount to more than 26,000. It is not strange that, faced with this immense mass of orderly arranged matter, those of us who have explored their intricacy derive from the study of crystals a satisfaction that is probably to be found nowhere else in the manifestations of nature. There is a keen sense of harmony in the realization that a certain crystal face will be repeated at its proper angle and that one may expect to find it in its properly ordered place beyond peradventure. As Gulielmine, an Italian crystallographer, writing in 1705, has put it, in words which now seem to be little less than prophetic:

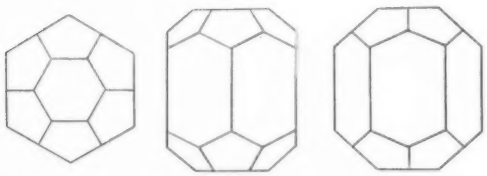
"Crystallization is a curious and wonderful operation of Nature's geometry, and therefore worthy of being investigated with all the genius of man and with the whole energy of the mind, not because of the pleasure which always attends the knowledge of wonders, but because of its great usefulness in natural science; for Nature here, as it were, discloses herself, and having cast aside every veil, permits us to behold not merely the results of her operations, but the very processes themselves."



Photograph by Leland Griggs

HEAD OF A FOX CUB

Perfectly balanced bilateral symmetry is expressed in this animal head. This is the symmetry of the higher animals and of man



Top and side views of the beryl crystal shown in perspective on page 167, illustrating six-fold and two-fold axes of symmetry

SOME MISTAKES OF SCIENTISTS

Errors in Research Honestly Made and Honestly Corrected

RECORDED BY FREDERIC A. LUCAS
Honorary Director, American Museum

In their search for truth, scientists occasionally find that they have been led astray—that conclusions have been drawn that could not stand the light of later knowledge. That the true scientist is interested in exact knowledge is proved by the care he takes in calling attention to the errors that he finds. The correction of a mistake is merely another way of adding new facts to his field of research.—THE EDITORS.

JUDGING from an occasional reference in the daily papers, there are still people who believe that a palæontologist can restore an animal from a single bone. Unfortunately this flattering belief is not correct. It belongs in the category of things that our papers state as "interesting if true." Please note that the scientist has never made this claim for himself. The ability has been ascribed to him, so to speak, by popular vote, or by the statements of popular writers.

This belief seems to date back to the days of Cuvier, the author of the law of correlation, the relation of one part to another, and of the combination of the parts to habits; that horns would belong with hoofs, hoofs with complicated grinding teeth, and such teeth with a creature having a complex stomach and feeding on plants.

And to the days of Cuvier dates the story of the student who, to play a joke on the master, arrayed himself in a garb composed of lion and cow and confronted him in one of the dark corridors of the Jardin du Roi. The master eyed him with contempt and remarked, "Hoofs and horns, claws and canines. Evidently, Monsieur you are unaware that such a combination is impossible, *va t'en.*"

A little later this gift seems to have been bestowed upon Louis Agassiz with the variant that he could restore a fish from a single scale.

Now and then Nature seems to evolve, or to have evolved, some creature with the express purpose of puzzling scientists and of showing that there is no law (of anatomy) without an exception. One of these exceptions was found in the limb bones of a big beast from South America on which was bestowed the name of Toxodon. Huxley was fond of pointing out that here was a creature (its a pity that "an animal" sounds so bad, because its a phrase so often used) as big as a rhinoceros, about whose relationships and habits we knew nothing, where the "law of correlation" broke down. When more of its remains came to light, it was found necessary to make a new group or order to contain Toxodon and its relatives. How puzzling this animal was is apparent from the fact that at least one of our mammalogists considered that in spite of its size—as just noted, it was as big as a rhinoceros—it was the ancestor of our rabbits; which reminds one of Henry Guy Carleton's humorous remark that the tarpon couldn't be a herring, because no one had ever seen a tarpon as small as a herring or a herring as big as a tarpon, but this was before Mr. Beebe went to Haiti. Before this, a Spanish naturalist objected to placing big Megatherium with sloths and anteaters, because "all the other Edentates could dance in its carcass." If the reader wishes to become acquainted with Toxodon, he will find a reproduction of his skeleton next the group of ground sloths on the fourth floor of the American Museum, while above him one of Mr. Knight's reconstruction shows us how he probably looked.

IGUANODON
As restored in Hagenback's Zoological Garden
The first iguanadon fossil to be found was fragmentary, and the hornlike thumbs shown on the fore feet of this reconstruction were not in place. Because of the resemblance of these "horns" to those of the rhinoceros, the suggestion was made that they belonged on the reptile's nose. Later another fossil was discovered and the "thumbs" were placed where they belonged

But if Toxodon was a puzzle, the beast now called *Moropus* was still more so. In 1825 Cuvier decided that a peculiar toe bone submitted to him for identification was unmistakably that of a giant pangolin, one of the so-called scaly anteaters found in Africa and Asia. A little later (1833) teeth from the same formation as the toe bone were referred to the Ungulates, and toes and teeth were found together in several localities until M. Filhol ventured the assertion that, while these fossils had been assigned to two very distinct groups of animals, they probably belonged together, an assertion that proved to be correct. But if the farmer's remark about the camel, "there aint no such animal," was excusable, he would certainly have been justified in applying it to *Moropus*, which must have looked something like a camel with claws and was totally unlike any of our modern mammals.

The dinosaurs proved especially troublesome since they presented some features in their skeletons for which there were no terms of comparison. One of the earliest of them to be discovered was Iguanodon, a distant relative of our Trachodon, and among the first of the remains found were some sharp pointed bones not unlike small horns, so one was not unnaturally placed like the horn of a rhinoceros on the nose of the animal. Later it was found that this spine was really a thumb, and it was pointed out that to put his thumb to his nose was really an undignified gesture for so ancient an animal.

Another mistake, not by a palæontologist, but by an artist with more imagination than knowledge, was when Waterhouse Hawkins, in making his reconstructions, provided Iguanodon with five toes. Professor Owen pointed out that Iguanodon had only three toes, to which criticism Hawkins replied that if they were corns he would gladly

remove them, but as they were toes they must remain.

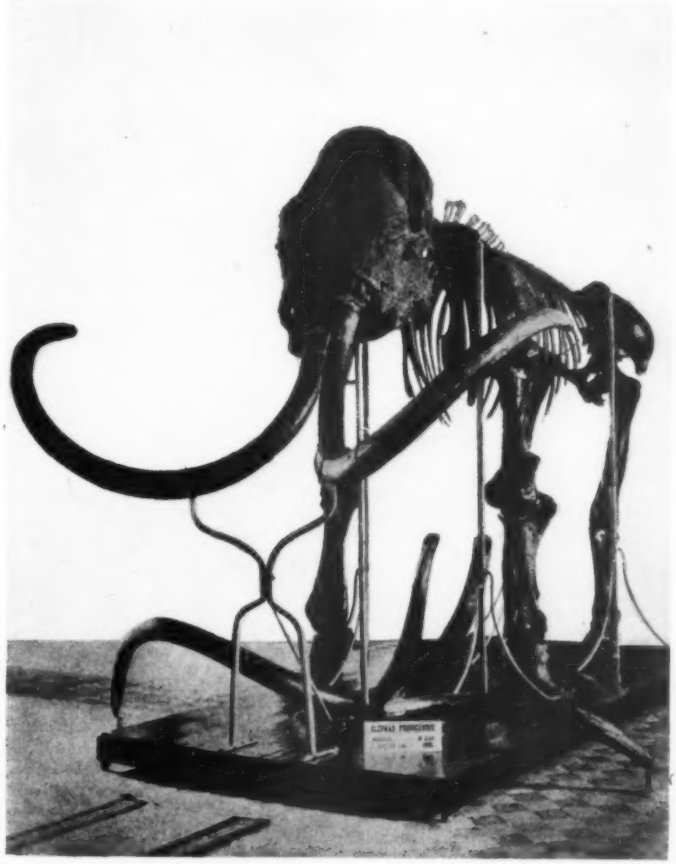
When Hawkins came to deal with Trachodon (*Hadrosaurus*) from New Jersey, he still further complicated matters by turning the slender pubic bones forward and making them epipubic or marsupial bones.

It is not surprising that mistakes have been made about fossil animals, since so many were, and are known by fragmentary remains, many of which belonged to animals without living representatives, for the palæontologist works backward, from the known to the unknown. Still, palæontologists are not alone in making mistakes, though they probably have more opportunities than other naturalists for so doing.

A curious specimen was brought to the British Museum from Japan, consisting of what seemed to be a short section of a rope of glass about which was a colony of polyps. While no silica-forming polyps were known, there appeared to be no reason why they should not exist, and this section was so described. But, later on, the glass rope proved to be the siliceous stem of a glass sponge and the polyps merely squatters thereon, who had built their colony around it.

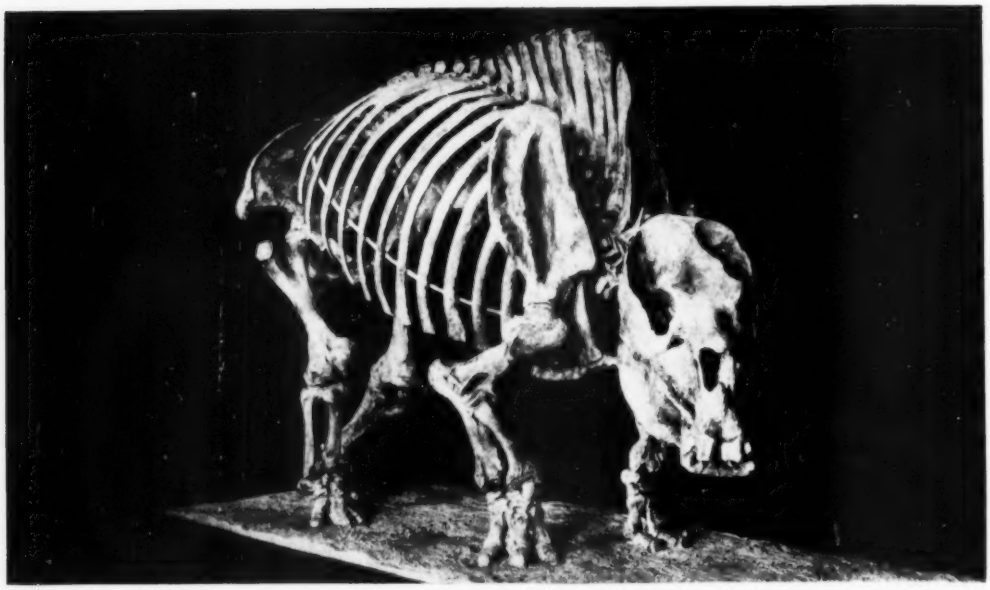
Quite a different origin was assigned to the beautiful skeleton of the "glass sponge," known as Venus' Flower Basket, which was received with suspicion as possibly the handiwork of some skilled Chinese artificer.

A simple and amusing mistake that for all I know is still in circulation, was made in an early description of one of our gophers, or pouched rats. One of the first specimens of these queer little rodents to be discovered was a skin brought in by an Indian, with the pouches turned inside out, and it was so described and figured. If the reader chances upon one of the earlier references to this animal he will very likely find it depicted with pockets like little



THE ST. PETERSBURG MAMMOTH

This skeleton of the first complete mammoth found was, by some strange mistake, mounted with the tusks reversed as they are shown in this picture. For about a hundred and fifty years this arrangement was accepted as accurate, until Charles R. Knight questioned the outcurving tusks, and later finds demonstrated that the tusks should have been placed so that the ends would curve toward each other



TOXODON

With the finding of this fossil creature the "law of correlation" seemed to break down, and a new group had to be made for Toxodon and his relatives

bladders, one on either side of the head.

But worse errors than this have been perpetrated by some of our best authorities. One described an elasmosaur, a kind of extinct sea serpent, with its head placed upon its tail, a bit of transposition that he was never allowed to forget. However, this author of what a rival palæontologist said should have been named *Streptosaurus* (reversed reptile) was not without some consolation; from the west came a huge horn core that should have come from some great ruminant and on which was conferred the name of *Bison alticornis*. But some years later was discovered a skull with two horns attached. The skull was that of a dinosaur, *Triceratops*, that lived several million years before any bison had appeared on the face of the earth; truly dinosaurs have provided many pitfalls for palæontologists.

One of the strangest and most persistent mistakes in regard to an animal, one for which, apparently, there was little excuse, was made about the tusks of the mammoth and mastodon.

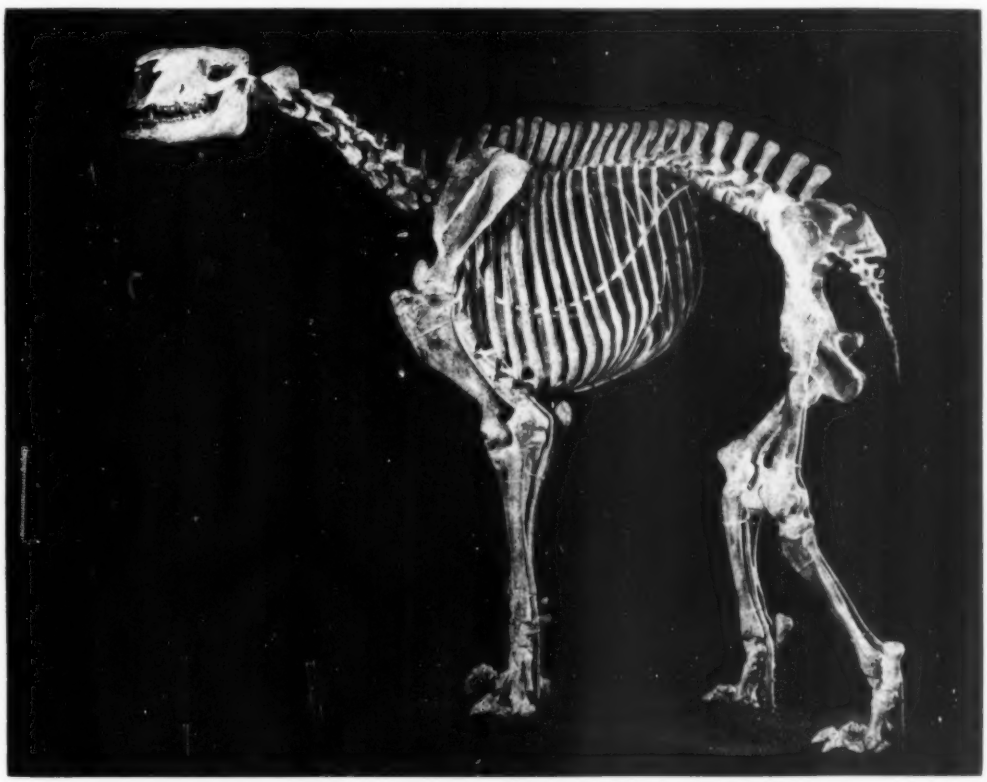
If anyone will look at pictures of the mammoth made before 1905, it will be found that, commencing with the Lena mammoth at St. Petersburg, the tusks are shown curving outward and backward, and a glance at a modern elephant will show that *his* tusks point forward and curve inward. How did the articulator of the St. Petersburg mammoth come to transpose the tusks, for that is what happened? Did he think that the mammoth ought to differ from modern elephants, and act accordingly?

At any rate, for more than a hundred and fifty years the mammoth was portrayed with these transposed tusks and I plead guilty to having helped perpetuate the error, for when I wrote *Animals of the Past*, both mammoth and mastodon were wrongly drawn.

So far as I am aware it was Mr. Charles R. Knight who first questioned the correctness of the accepted portraits of

the mammoth, and a careful examination of the few tusks then available showed that the trunk had rubbed them just as it rubs the tusks of elephants today, on the inner side. And then came the Indiana mammoth to clinch matters; this venerable beast had apparently lived a long and tranquil life, and had plenty to eat, so his tusks had grown accordingly, until they lapped by one another for about two feet. It was a physical impossibility for *his* tusks to have curved outward and backward, and so, after having passed current for more than a hundred and fifty years, the mistake was corrected and the tusks were properly portrayed.

Last, in this article, is the giant octopus. There washed up on the coast of Florida many moons ago a partly decomposed mass somewhat sacklike in shape, with a frayed-out fringe about it. It was well known that in the depths of the sea lurked giant squid, and as large octopuses had been found on our Pacific coast, there was reason to suppose that bigger still might be found. After due study of photographs and glowing accounts by non-scientific observers, the mass was named *Octopus giganteus*. However, some doubting Thomas put a piece of the animal into a big jar and sent it to the National Museum, where the jar was opened by a member of the staff, who promptly said "Blubber," a remark that was repeated by the friend to whom he showed it. And blubber it was, for it proved to be the



MOROPUS

This beast, which must have looked something like a camel with claws, upset several theories. Hoofs were thought to belong invariably with complicated grinding teeth but, while this creature had the grinding teeth, he had, instead of hoofs, an extraordinary set of claws

A GOPHER, OR CANADA RAT

As figured in Shaw's "General Zoology"

One of the first of these little rodents to be discovered was a skin brought in by an Indian, with the pouches turned inside out. Accepting the pouches as naturally belonging in that position, the gopher was so described and figured. The pouches should, of course, be tucked inside

wave-worn case of a sperm whale, from which the spermaceti had been taken before it was cast adrift. As an English writer observed, this shows the difficulty of sitting in Connecticut and describing a species in Florida. And now there can never be an *Octopus giganteus*, for by the rule, "once a synonym always a synonym" the name has been attached to the sperm whale and can never properly be applied to a cephalopod.

Apropos of octopus: many years ago Professor Morse pointed out that Victor Hugo in his *Toilers of the Sea*, made an amusing mistake. If anyone will take the trouble to read the lurid description of the devilfish, he will find some curious properties ascribed to the creature; to mention one, that of withdrawing its arms like inverting the fingers of a glove. Turning to a French encyclopedia, one finds that octopus is *poulpe* and the coral animal *polype*, just a difference of a letter, but that letter seems to have made all the difference in the world, and given rise to the glowing composite description by Victor Hugo. Rest assured that it is not alone scientists who make mistakes.

Professor Cope once told the writer that a man is bound to make mistakes, and that consequently the more work a man performs the more mistakes will he make. But let him be judged by his work as a whole and not by his errors; for each of the mistakes herein recorded, the author thereof made many valuable contributions to knowledge, and by these will he be remembered.

Humanum est errare

THE CAVES OF MT. ELGON

A Series of African Caverns Inhabited by Natives Who Still Are in a Stone Age of Their Own

By JAMES L. CLARK

Assistant Director, American Museum

IT was late one afternoon a number of years ago when our long line of tired porters, with ourselves in the lead, stopped at an isolated log-and-mud hut on the rolling, grassy plains of East Africa. We were tired enough to be sure that we had traveled more than far enough to have reached our destination at Sergoi, but still the village we had been expecting to reach was not in sight. The west had begun to color as the sun was sinking behind the only prominence on the distant horizon and, as the glare of the light softened, we could see the prominence take a definite form, a purple silhouette against a liquid, golden sky. It was a lone mountain with its convex sides sloping upward from a broad base, forming a truncated cone. Surely, we thought, this must be the extinct volcano of Elgon.

Sergoi showed on the map as a good-sized dot. We thought from that that the place was one of some importance, but we had come upon nothing save this single shelter, and it seemed that the village must still be afar off.

The chatter of our boys drew a somewhat seedy white man to the doorway.

"How far is Sergoi, sir?" we inquired.

"Not far, you're at Sergoi now," he replied.

We looked around to see if we had missed the village, but could see nothing but plains in every direction, except where a small bush-covered hill rose not far back of the hut.

"We thought Sergoi was an important place with a District Commissioner," my companion exclaimed.

"So it is," agreed the man. "The boma is just on top the hill there, in those little trees."

Although we looked hard we could see no sign of a house, nor could we make out enough room on the top of the little hill to hold a house suitable for a District Commissioner.

"If we go up and see the Commissioner," I suggested, "maybe he can help us out."

But the man replied that the Commissioner was away on some native business and only his servants were at home. As we seemed somewhat perplexed he invited us to stop a while. We entered his home to find it a sort of store, stocked with canned goods, clothes, and a few other articles that both white men and natives might buy. While he made us some tea we chatted, and we learned that he had lived where we had found him for about twenty years.

For some reason this abstract township was well known, and it took on more importance than one might think. Very few white men traveled that way, but wandering natives often passed en route to other districts because, perhaps, the tiny hill is the one point of significance in the whole surrounding country and becomes a veritable beacon that serves as a milestone on the veldt.

"Where are you fellers going?" the store-keeper inquired after a while.

We told him of our plans—that we were headed for Mt. Elgon, but first were to meet Colonel Roosevelt and his safari and collect some elephants. Carl Akeley, who headed our party, did the explaining. He and Colonel Roosevelt had planned

BUILDING A TEMPORARY BRIDGE

Among the higher foothills of Mt. Elgon there are occasional swift streams that are far too deep and swift to wade. Across these mountain torrents crude bridges were built by Mr. Clark's party in order that their belongings could be transported with less risk of a wetting

before leaving America to meet in Africa and hunt elephants together, and Akeley was to take the skins for the big group that was eventually to form the centerpiece of the African Hall in the American Museum.

The storekeeper told us that the Colonel had gone by some time before and was hunting somewhere between this point and Mt. Elgon, so we were keen in our anticipation of the meeting.

As we watched the sun disappear behind this mysterious mountain, it seemed to fascinate us, and we talked of the possibilities of going nearer it. The more we inquired of this man who had lived almost in its shadow for a score of years, the more we wanted to explore it. Hardly a handful of men had ever been to its base, and very little was known of it. The storekeeper had never been there and knew of no one who had. He warned us not to attempt it, saying the natives living in its forests were very bad indeed and would shoot us with poisoned arrows without ever giving us a chance to see them.

We made camp near the store and stayed for the night. The morning found us marching early, headed west with Elgon as our landmark. For two days we traveled, hunting a bit here and there, finally making contact with Colonel Roosevelt and securing rather unexpectedly the elephants that were so keenly desired. With the skins properly cared for, and the Colonel again on his way, we turned our thoughts again toward Elgon, for now we were almost at its base.

Supplies were low, but we believed we might secure native flour and rice enough to carry ourselves and our men through the rest of the journey. So we headed directly for the base of the mountain, where we expected to find a tribe called

KITOSH GUIDES AT THE ENTRANCE TO ONE OF THE ELGON CAVES

These "boys" had been assigned to Mr. Clark's party by their chief, but only after prolonged negotiations. It is probable that the spears carried by these men were manufactured by the Masai or the Nandi, and that the Kitosh had obtained them by barter

MR. CLARK'S SAFARI RESTING AMONG THE FOOTHILLS OF MT. ELGON
There were from sixty to seventy porters in this safari, in addition to an ox-cart that carried the bulky goods. Every half hour or so the party dropped its bundles for a rest, for the altitude and the heavy loads precluded longer marches between stops

the Kavarondo. From what we had been able to learn, these people were not unfriendly and, to help matters, we had secured from the storekeeper at Sergoi a quantity of trade articles, such as beads, blankets, and iron wire, to win their favor.

As we neared the mountain we found no villages, only a few well-worn trails that appeared to be those of game. The whole country was crisscrossed with comparatively fresh elephant trails where herds had trampled the grass or broken down branches as they passed.

It was here that I saw my first "honey bird" and its strange actions—an interesting little black and white fellow about the size of an English sparrow, that through some instinct has learned to associate itself with man to get its coveted feast of wild honey. My attention was drawn to an incessant chirping over my head and, looking about, I saw this little fellow darting ahead of me into trees beyond. I realized then that the racket had been going on for some time before I heeded it. Somehow he had learned the location of a wild bees' nest. On such an occasion when man, either native or white, comes within sight, the honey bird goes after him, attracting his attention by its noise, while it darts ahead in the direction of the nest. If the hunter heeds and follows, this little bird will lead on, but if not, it gets all excited until the man starts going in the right direction again. When the hunter finally comes near the treasure-laden tree, the bird quiets down and sits on a near-by branch.

If you are honey-bird wise, you will look around for a big hollow tree that might be shielding a wealth of golden nectar. Then, with a bundle of half-dried grass lighted as a smudge, you climb for the raid. What you spill is sufficient for the honey bird's reward and all are happy except the bees.

In this same way this clever little fellow coöperates with the honey badger, which raids and pays by the leavings.

Whether to turn north or south in this land of game trails we did not know, but luckily we chose the right direction when we took the southern trail, and after another two days came to a herder who led us to his village. Here we were met with much curiosity, but not in an unfriendly manner; in order to make sure of our standing, however, we camped and did everything we could to establish ourselves definitely with the natives. They were not the Kavarondo we had expected to meet, but a tribe called the Kitosh.

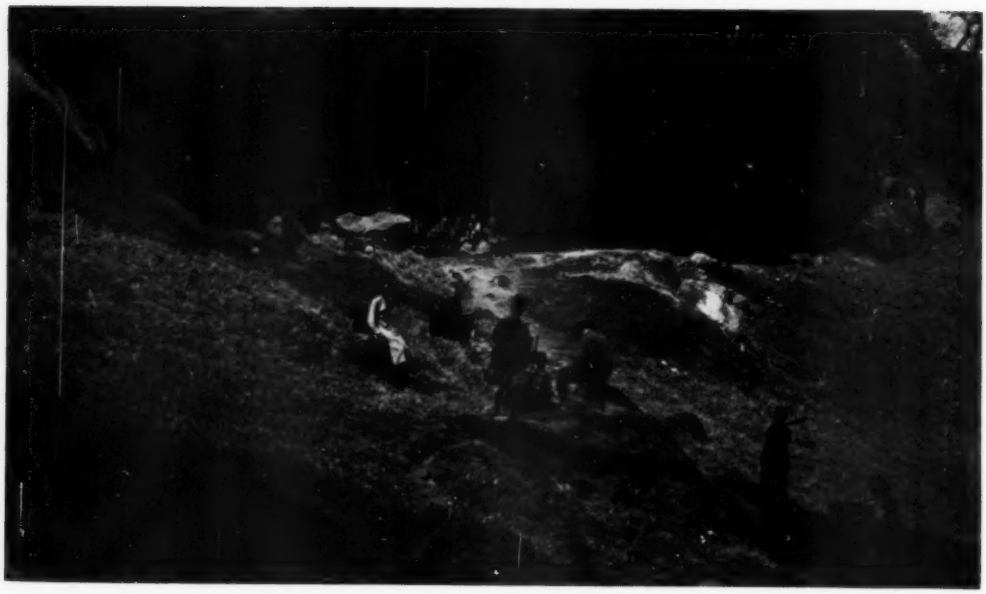
We thought that a day would obtain for us the desired food and friendship, but they seemed in no hurry, and we could not force matters. Each day the old chiefs would come "in state" and pay us a long visit, while we wasted valuable time trying to be nice to them as we bartered for our supplies and for men to guide us. Whether or not they had ever seen white men before, we never definitely learned, but their curiosity was aroused at everything they saw in our equipment. Our safari must have been to them as a circus is to small boys, for they kept us waiting for three days before the supplies and men were in our hands.

At last, saying "good-bye," we followed the five spearmen we had obtained, along the base of Mt. Elgon, and then started our long, gradual ascent. Around the base of the mountain there was rolling country, open scrub with occasional large trees. For the most part, although now we were at an elevation of about 6000 feet, it was rather arid. As we climbed, heading northward on to the very base of the mountain, we began to enter forests that became more dense.

At the end of the first day we had climbed well up the side, and we made camp in a glade. We had some anxiety

PEOPLE OF THE CAVES

Though these people slightly resemble the higher type Masai, there seems to be no close relationship. They live in or near the caves of Mt. Elgon, and have their "shambas" or small gardens close by. Their small herds of cattle and sheep are driven within the cave entrances each night



THE FIRST CAVE VISITED BY THE CLARK PARTY

The people who lived in this cave ran away upon hearing the approaching party. Later a few of them returned and admitted that they had believed the newcomers were a raiding band of neighboring savages

as to the natives, although we believed we were still in the land of the friendly Kitosh.

The next morning we had not gone far before we came to a "rim rock" that occasionally showed itself projecting above the forest. This could be traced for some distance along the mountain-side. It was among this formation that we found the remarkable caves for which we were looking, and of which Rider Haggard made so much when he wrote the weird story of *She*. Our guides led us to a group of these caverns and we spent the rest of the day exploring them.

The rock projected as a shelf from the rather steep slopes and occasionally there was a natural cave which ran horizontally into the ground for unknown distances. They were evidently formed by erosion and in some of them the natives had established homes. Who these people were we could not learn. We saw none of them, for they had decamped when they saw us coming. That they are different from those who guided us from below was apparent from many signs, and when we asked our guides who these cave dwellers were, the only answer was "Shenzi"—wild people. This, however, meant very little indeed, as all African tribes consider any other people but themselves "wild people," each tribe being in its own estimation the one superior race.

The abodes in the caves were very primitive. There in the dark caverns one went back fifty or a hundred thousand years and found himself at the very fireside of the cave man. Elephants were about us in the forest, and rhinoceroses were roaming the rolling plains hardly a stone's throw below. Certainly we were in the heart of a primitive land. Here was man, still in the savage state, with stone and wooden implements of the crudest workmanship; with little stools made of split logs, flat side up, the branches cut off to form the legs.

A few simple, wrought-iron axes, smelted from the surface iron and pounded

crudely into shape, were in evidence, for they had advanced so far as to make tools to till small patches of ground. Granaries, simple and crude, woven of brush, stood on stilts sheltered just within the entrance to one of the caves, while at the other side, where the roof sloped back, a section had been barricaded with heavy sticks set in the thin layer of soil and interwoven with others to form a one-room house—drafty, open, crude—hardly more than a bird would make and certainly much less ingenious than the home of many of the common birds.

Not a thing could be seen to indicate that a civilization existed on their globe. They did have a few cattle and sheep, which they sheltered within the cave at night and protected from leopards by a fire at the entrance.

We passed on back into the caves, but found no end, and dared not go beyond the light of day lest we should be forever lost in a hopeless labyrinth that might be ready to entrap us. In the darkened chambers hundreds of bats as big as rats whirred about our heads with a roar of disturbed air like the sound of an approaching storm. Emerald beads in pairs gleamed at us by thousands wherever a ray of light from narrow passages refracted on the eyes of the creatures as they clung in solid masses to the walls.

No native had ever dared to enter these depths, and perhaps they had never been explored. The minute droppings of the untold thousands of bats had fallen and covered the floor with a layer like snow, smooth and even, inches deep in most places and a foot in others, proving by its undisturbed surface that this sanctuary had not been entered by man or beast. If it had, the tracks would have remained uneradicated for a generation.

When we came out, we found that some of the frightened cave dwellers had re-

A VIEW FROM WITHIN THE FIRST CAVE
Inside the cave stood a few simple structures. The two shown in this picture are wicker granaries set on stilts in order to protect the contents from moisture

turned—a mother and her tiny, shiny black tots. No men were about. They, no doubt, never expected that their retreats would be visited. They may never have been. We believed these fellows were out hunting or herding their stock in some of the open, grassy glades.

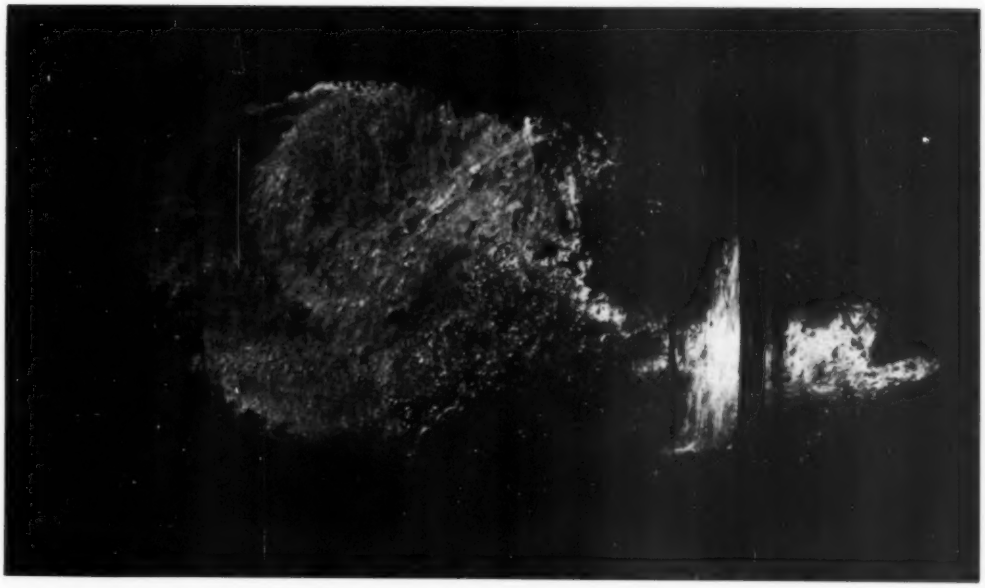
Sitting about the fireplace at the entrance to the cave, we commanded a most magnificient view of a great sweep of country below—a vista that rolled off for miles to the horizon. Time passed all too quickly on this first visit and we had to move on again, winding up glades, through forests, ever going upward. Our boys had told us of other caves farther up the mountains—but they seemed to have a fear of them and spoke of them with much superstition.

The following day we were on our way again, now through a jungle almost tropical—immense trees and vines, with moist ground beneath and with here and there a grassy dell where the sun came shining through. Toward the end of the day our guides told us that we would soon be near the mysterious caves and we pushed on, doing our best to have a chance to visit them before dark.

It was late in the afternoon when our guides halted and told us we must now go through the forest from this point if we wanted to see these other caverns, so, leaving our safari, and telling them to go on and make camp at the first good spot on the trail, we made our way along the slope. The trails were indefinite and often petered out—hardly more than game trails. Finally our boys stopped. We had come into an open glade and were standing on the edge of a ravine which dropped abruptly for thirty feet or so. The sides were covered with scrub, and we heard the sound of water below us but could see none. Upstream a short way we could see the end of this ravine,

THE CAVE OF THE WATERFALL

The entrance to this cave is through the small opening shown at the left. It is necessary to leap into the darkness beneath the fall, which barely shows above the bush in the center of the picture



A VIEW FROM WITHIN THE CAVE OF THE WATERFALL
The little waterfall shows plainly here, as well as the path that leads into the cave. When the Clark party entered, they found that the cave had been deserted some time before by its inhabitants, for the crude huts were partly fallen down

where the bush was more luxuriant. A tangled growth seemed to bank the end, while over this blanket of green spread a lovely waterfall. There were some dark spots in the green, and as we came closer, we saw that they were holes. The guides told us that this was one of the many caves and that this one was known as the "cave of the waterfall."

It seemed a difficult one to enter, and they told us that the only way into it was along the other side of the ravine and finally in under the falls to the large hole that the falling water partly covered. As this seemed quite impossible without our getting a good wetting, we decided to go to our camp for the night and return in the morning in order to do our exploring when the light was better.

As we marched along the trail, following our boys' footprints, we wondered how far they had gone, as in this forest there seemed little chance of a camping spot. It was but a few minutes, however, before we began to see clumps of bamboo, and shortly the transition was complete. We had left the forest behind and now were surrounded by tall swaying bamboos. A chattering ahead told us we were nearing camp and presently we saw blue smoke —a decided blue accentuated against the dark green of a bamboo forest wall.

There was camp, in a beautiful grassy spot just large enough to hold the circle of tents, with a blazing fire looking cheery in the cool forest twilight.

We knew by the presence of bamboo that we had reached an elevation of close to 7000 feet, and after supper we did not linger long, but crawled into our blankets to get away from the chill night air. We were called at daylight, and the usual cup of hot tea, which was brought by our tent boys, gave us warmth and courage to leave our snug beds.

It was a weird but a fascinating camp, in a deep green hole, with tall, lace-topped bamboos fencing us all in. We could see nothing but the sky, and again watched the curling smoke of the camp

A CAVE DWELLING ON MT. ELGON

The wicker granaries are shown at the right and left, while a native hut is shown against the cave wall in the center of the picture. A simpler dwelling could hardly be built. Many types of birds' nests are more complicated and more comfortable

fire in the still morning air until the beams of golden sunlight touched the top of the bamboos and began to creep down the stalks. I shall never forget the beauty of the reflected golden light flooding our well of green. Africa is truly a wonderland, and a single morning like this is worth the trek of a year.

But we could not wait for the sun to warm us, so we started for our cave, knowing that by the time we got there the sun would be shining into it. We followed the guides down across the little ravine, and hugged the wall of the opposite bank until the very water of the falls sprayed us. We could not see then how we were to get into the cave. But finally, as we stood there, our guide made a dash, and then I saw him leap and disappear behind the screen of water. Shortly he called, and another followed. Then I decided to try it. It was a strange feeling to make a dash into the unknown behind that water, but I started, and when I was in mid air, clearing the pool below, I could see where next to go. As I alighted on a big rock I turned and came immediately behind the wall of water, almost touching it. From there I could see into the cave and, as the rest followed, we started our exploring trip.

The air was damp and cold, yet the ground of the cave was dry and powder-like. The entrance was small and narrow, like a foyer, but from that there opened a great chamber, probably fifty feet square, and with a high, domed ceiling. It took a little time to adjust our eyesight to the darkness but shortly we could see quite well, as the sun had now struck into the little ravine, throwing considerable reflected light through the small entrance. At the back of the cave we could see other black openings leading farther, but how far we could not tell. As we came near to these openings, we noticed that they

were caused by tremendous blocks, weighing hundreds of tons, that had fallen from the ceiling. The formation in this cave was dark brown conglomerate, which contained many scattered pieces of petrified wood, while the first cave we had visited was formed of a gray limestone. Some have said that these caves are forgotten mines, but this I doubt.

As our eyes became more accustomed to the dim light, and we could see farther into the darkened corners, to the left we noticed for the first time some huts. There were three or four, but only one or two remained in good condition. They were round, about ten or twelve feet in diameter, with straight sides about four feet high, and flat tops. A single small doorway was the only entrance to each one. The huts were constructed of bamboo sticks driven into the ground at distances of a foot or so. They were intertwined with the long flat bamboo "leaves" that come from the stalk. The roof was similarly made, and the whole structure was plastered with mud. In the center of each were the ashes of a fire. Otherwise there was nothing of significance.

These huts had not been used for some time. I looked about for remains of implements or telltale signs of those who might have inhabited them, but could find nothing. Our natives, neither guides nor porters, could tell us except to say "Shenzis" again, and we wondered if they were the wandering people of the bush who we had been told would shoot us with poisoned arrows.

Our little flashlight was weak and next to useless, but we worked our way over a great block and finally slid down the other side, now in total darkness except for our

ABANDONED HUTS OF THE CAVE OF THE WATERFALL

The rough conglomerate roof contained many bits of petrified wood, and two large bowlders that had dropped from the ceiling are shown behind the huts. The party penetrated far into this cave, and finally stopped at the brink of an abrupt drop below which lay a pool of water. So deep was the pit that the beam of the pocket flashlight carried by the party did not reach the surface of the water, though they knew that it was there by the sound of the splash when stones were tossed into the blackness

dim lamp and a faint ray of light over the top of the big block that told us where we had come from. We were in a small chamber, evidently a part of the big one before the block had fallen. Ahead we could see a small hole and, getting down on our hands and knees, we crawled through. It was uncanny and dangerous business and I didn't like it at all.

We found we could stand upright, and as we did we heard a weird sound, a sort of wail—the wail of a banshee. Swinging our little lamp about, we could see nothing but the ground immediately in front, rocky and rough. We called, and our voices echoed back as if in an immense chamber. Bats whirred about our light and our heads in hundreds, until we thought they would surely strike us. Cautiously we moved forward with the light on the ground, testing every step before we trusted our weight. Pools of crystal clear water lay here and there, but they were filled with dead bats in all stages of decomposition. As in the other cave, we were undoubtedly the first ever to enter here, as the bat droppings lay soft and very thick like dust on the floor and rocks, and our feet sank deep as if in snow. The mournful wail got on our nerves, and seemed to come from above, so we peered up into the inky darkness which our weak light failed to pierce.

Suddenly we saw a tiny ray of light, a mere dot like a star. We could not make it out. For some time we pondered over this, and then made it out to be a tiny hole through to daylight. As we watched, the wail continued, and we decided that it was nothing more than a current of air rushing in through the cave door and out through this little hole.

Satisfied with this, we continued a bit, ever cautiously, fearful that we might lose

ANOTHER DESERTED HUT

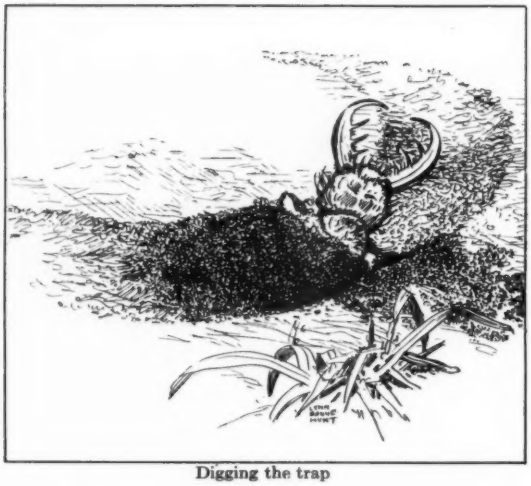
This delapidated hut was of a higher type than were those in the first cave to be visited, but the builders had long since departed, leaving the cave to the innumerable bats

IN THE CRATER OF MT. ELGON
The size of these giant groundsels can be visualized by searching for the man standing at their base in the center of the picture

the direction of our retreat. We came to a ledge and below and beyond on all sides was that inky blackness. Again we threw stones ahead to sound the ground, but did not hear them fall. Then a heavier one was cast, and it seemed seconds until a faint splash met our ears. Somewhere, way, way down, was water. That was enough. We were on the edge of nowhere and thought we had best go back.

We returned and cast our light about; the tiny green emeralds again flashed as they hung in clusters on the walls. This was our chance to secure some. We hesitated for some time, debating whether we should dare fire the shotgun. The tremendous concussion might loosen more of the ceiling that might be hanging only awaiting something much less than this to bring it down. But it was a chance to serve science and we decided to take it. We stood side by side while Akeley pulled the trigger. The terrific roar that followed set both the echoes and the bats to flying until the air seemed almost solid. We groped our way to the base of the wall where many had fallen, and selected those we wanted. There were three different kinds.

We were glad to return to the open air and to see the daylight again. But relieved though we were to leave the eerie cavern, we were glad to have explored it, and to have compared it, in our imaginations, with the cavern of Rider Haggard's "She-who-must-be-obeyed." But though the Caves of Mt. Elgon are almost as wild and weird as are the imaginary caves of *She*, the gentle black people who carried our kit could never for a moment be imagined as comparable to the fearful Amahaggar tribesmen that Haggard invented, nor were we the less pleased on that account, for any visit to the Caves of Mt. Elgon is likely to be adventurous enough for comfort, without the murderous activities of any such tribe as Haggard's impossible Africans.



Digging the trap

LITTLE "BEASTS OF PREY" OF THE INSECT WORLD

How the Ant-Lion Larva Builds Its Trap and Obtains Its Food

By FRANK E. LUTZ
Curator of Insect Life, American Museum

Doctor Lutz has for several years been making a study of the number of insects to be found in his own back yard near New York. He has discovered more than 500 species. These specimens are being placed an exhibition in the American Museum as proof of the abundance of nature-study material right at our very doors.—The Editors

WE have not, so far as I know, had larvæ of ant lions living in our yard, but there must be some not very far away, since an adult, looking like a pale, flimsy, night-flying dragon fly, was found at our porch light. Unlike dragon flies, adult ant lions hold their wings close to their bodies when at rest. Our soil is not loose enough to suit the larvæ and we have no overhanging shed-roof or anything of the sort to make a relatively dry spot on the ground. I am tempted to fix a place especially for them and, if necessary, import a few larvæ from the yard of some more fortunate person—but, of course, I would not count these among the five hundred insects that I have found in our suburban New York yard.

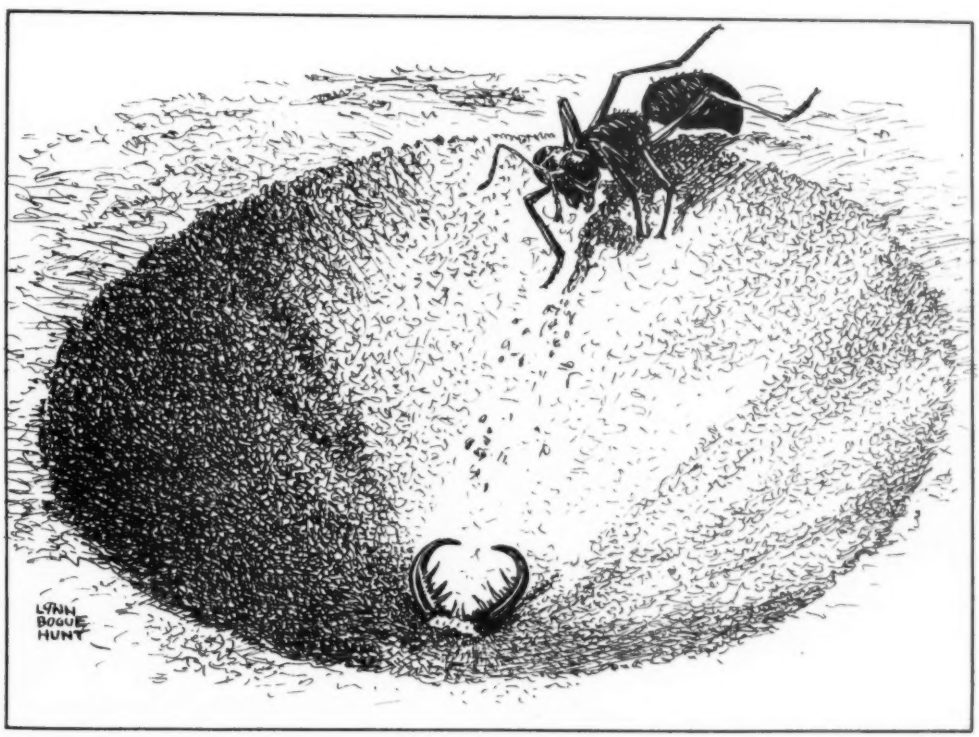
I once joined a party of tourists who were "doing" the old cliff-dwellers houses in the Mesa Verde National Park of southwestern Colorado. On that occasion the professional guide was barking his speech with the facility of long practice, when he was rudely interrupted by one of the party pointing to conical pits in the dust that formed the floor of the house, and asking if the roof leaked. The roof was the whole top of the cliff but the guide "reckoned maybe there was a drip." I happened to have a broad-bladed knife with me and, after thrusting it under the bottom of one of these pits, I raised it quickly and flipped out one of the homeliest-looking creatures an ordinary person would care to see. For a while the ancient cliff-dwellers were forgotten and some of the present-day tenants of the ruined dwellings held the center of the stage. The conical pits were traps made and tended by larvæ of ant lions, a thing four-footed lions do not do.

Mother Ant Lion lays an egg here and there on, or slightly in, loose earth, and after that it is entirely up to her offspring to take care of themselves. They live by

killing and eating other insects, and although they have large, sickle-shaped jaws, their legs are too short to travel the rough ground. They have never seen a trap made, have never seen even a completed trap, and yet they go about making a rather efficient one. You can easily watch the process by putting a larva on an inch or so of sand in a dish.

First, the larva pushes its way below the surface, flipping the earth up by jerking its head. Then it begins traveling just under the surface, flipping the dirt up as it goes. But, and here is the interesting point, it travels in a circle that is perfect—almost. Instead of being a perfect circle it is just enough short of one so that the path spirals toward the center. How the larva does it without being able to see anything or to touch a central point, I do not know. To me it is more marvelous than the spinning of a spider's web or the leaf-cutting of a Megachilid bee. As it works toward the center it goes deeper, continually flipping, until finally it has made a conical pit at the bottom of which it lies completely buried in the earth except for the sharp tips of its jaws, which project into the bottom of the cone.

Now for results. An ant or some equally small and equally inquisitive or careless insect comes along and steps on the edge of the pit. A few grains of dirt rattle down the sides, and flip goes the head of the larva, sending a whole shower of particles up to slide back into the pit, carrying the small, inquisitive, or careless insect with it. The sharp points of the waiting jaws do the rest. Could you improve on the plan? How did the ant-lion larva, that never saw such a pit and

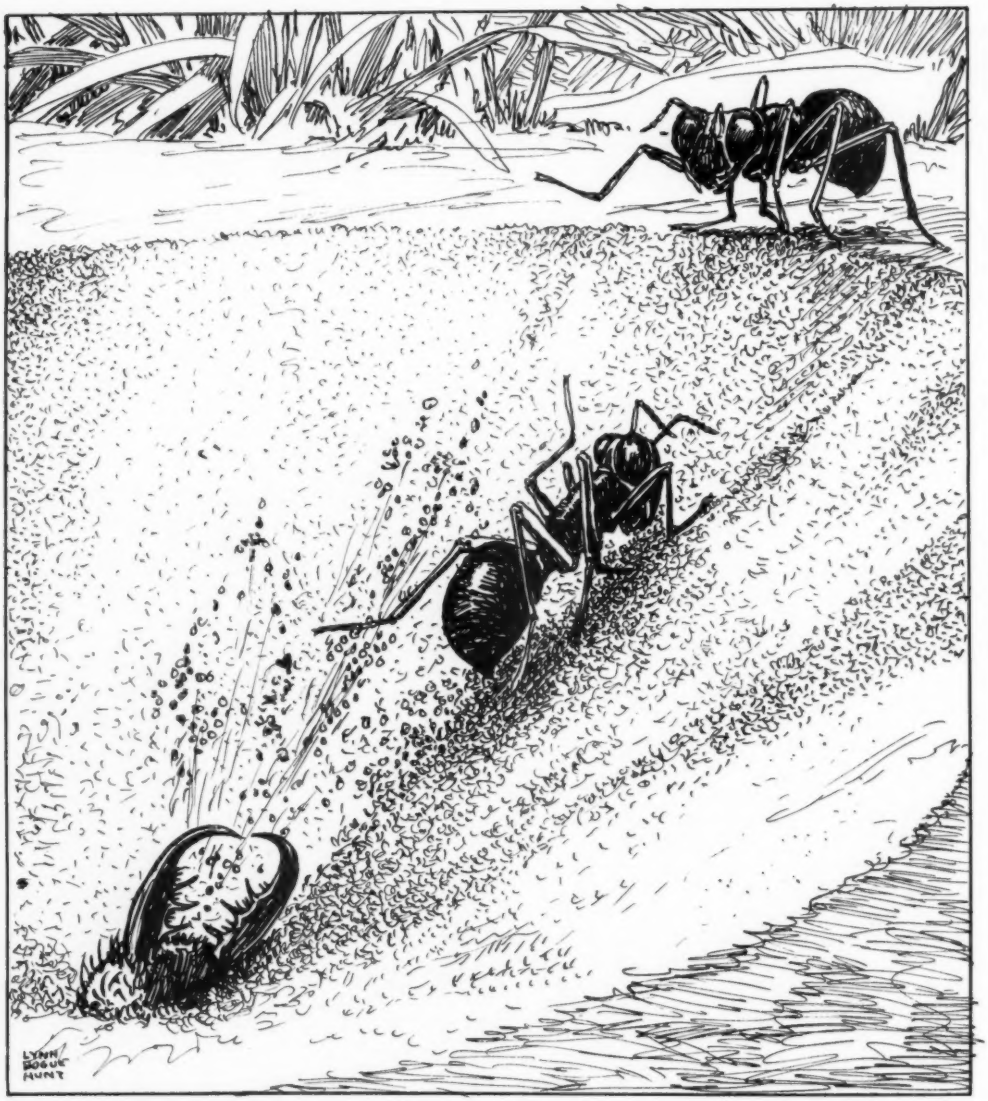


THE COMPLETED TRAP

A prospective victim is entering the trap. The trapper has buried itself at the bot om of the pit and calmly, but with jaws in readiness, awaits the next step

that never saw its parents, learn how to make and work the contraption to its advantage? When you find this out you will know something about the development and inheritance of instincts.

The rest of the story seems simple because it is more usual. When full-grown, the larva spins a cocoon under ground, pupates, and finally emerges as an adult that looks like a pale, flimsy, night-flying dragon fly whose wings, when at rest, fold close to the body. When it flies to a porch light, it does so "instinctively" but to its disadvantage, because that is usually its unprofitable end. So, before you know everything "about the development and inheritance of instincts" you must know about this, too.



THE TRAP IN ACTION

One unfortunate ant is trying to climb out of the pit, but the shower of sand, thrown by the twitching of the trapper's head, will doubtless roll the unwary one within reach of the trapper's jaws. The thoughts, if any, of the ant at the edge of the pit may be left to the imagination

From a Group in the American Museum

The scene is on the San Carlos River, Arizona. In the middle distance the construction of an Apache house is shown in progress. In the foreground is a flat-topped "shade" splendidly adapted to Arizona climate for summer living purposes

NATIVE DWELLINGS OF NORTH AMERICA

Some of the Numerous Structures Inhabited by Aboriginal Americans

By PLINY E. GODDARD
Curator of Ethnology, American Museum

TO the average person the tipi is, perhaps, the typical American Indian dwelling. This impression has been fostered to some extent by the "wild west" fiction of the last three quarters of a century, but as is the case with most such impressions, it is wide of the truth. The houses built by the natives of North America in pre-European times varied greatly in shape, size, and material. To some extent this variation was due to geographical and climatic conditions. Snow houses would hardly be durable in Arizona, even if the material for their construction could be secured there. Nor are houses of split planks to be expected in the treeless regions of the Arctic or of the great plains.

The type of habitation used by any people is conditioned chiefly by the sort of economic life they pursue. A hunting people may be compelled to follow the migrations of the game and therefore have either portable habitations or else simple ones which can be quickly built and abandoned without great loss. In America it frequently happens that several occupations are followed according to the season so that there are regular movements to streams or the ocean for fishing, or to the uplands and mountains for game or wild vegetable food.

The size of the dwellings in many instances depends upon the social customs and what is considered a family. There is a tendency in certain regions for the sons, when they marry, to remain with their children in the parental home. Among other tribes it may be the daughters who remain after marriage. In either case, the household consists of four or five biological families.

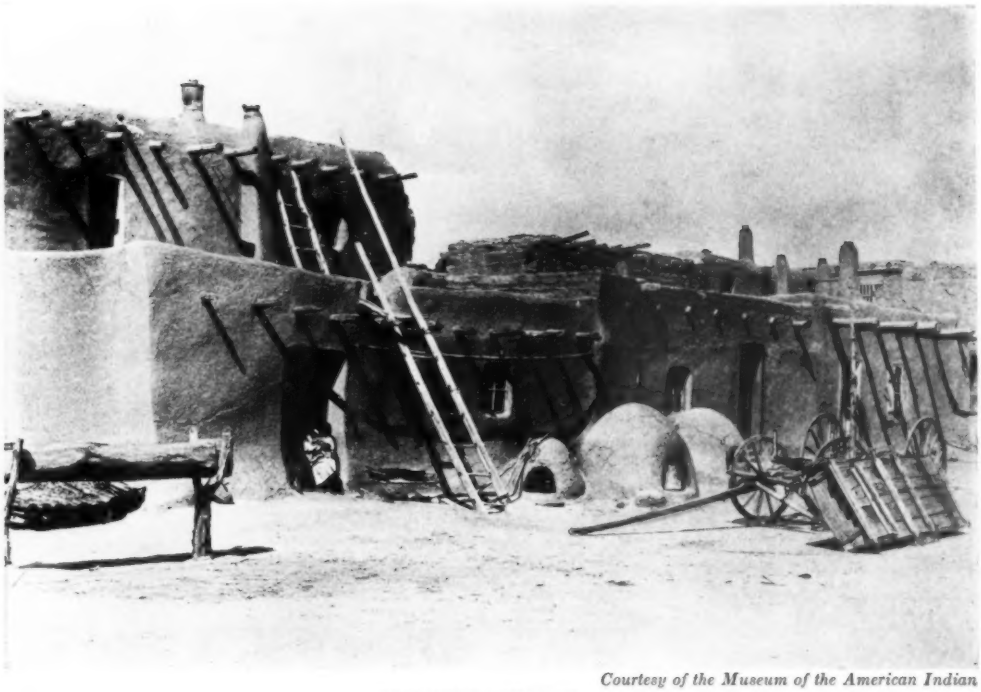
Courtesy of the Museum of the American Indian

A PUEBLO

In this village of San Ildefonso in the Rio Grande Valley, New Mexico, the houses are of only one story. This is probably due to European influence. In the background is Black Mesa, a prominent feature of the landscape and of great sentimental importance to the Indians of the region

HOPI INDIANS

The village of Walpi on the First Hopi Mesa in New Mexico is the best known of the Southwest pueblos. The snake dance held here biennially is attended by thousands. A family is shown busily engaged in domestic duties on the house roof in the American Museum group of which this is a photograph



Courtesy of the Museum of the American Indian

SAN JUAN PUEBLO

This portion of the village of San Juan in the Rio Grande Valley of New Mexico shows how the second stories of the houses are terraced back, so that the roofs of the first stories become the porches of the second. In ancient times the walls of the lower stories were unpierced and the rooms were entered by means of ladders

Courtesy of the Museum of the American Indian

A SUMMER HOUSE

The women and children of a Navaho family at the entrance to their summer house. These houses are temporary and take many forms. They are built to furnish shade and shelter from the prevailing winds

Photograph by Macmillan

SNOW HOUSES

The winter houses of the Eskimo are dome-shaped and built of blocks of hard snow held together by a keystone

The differences in houses, as in other phases of life, are chiefly traceable to habits and customs which have originated in the remote past. A son builds a house like that in which he was born because he is accustomed to that sort of a dwelling and he knows how to build only that kind. Stone suitable for building is found in many regions, but nowhere north of Mexico did the Indians know how to arrange it so as to roof over spaces. The first-growth pines of Maine would have yielded excellent building planks, but the Indians there lacked the knowledge and skill possessed by the Northwest Coast Indians for working wood.

If we begin at the North with the Eskimo, we have a people given to seasonal migration with two kinds of habitations. In summer they go to the interior to hunt caribou both for food and the skins from which their clothing is made. The caribou migrate both with the season and with the prevailing winds. During the summer the Eskimo live in skin-covered tents with such frames as can be made from the scanty timber of the district or from the bones of whales. In winter these people live close to the sea where they can fish and hunt sea mammals. As soon as snow accumulates and becomes hard packed, dome-shaped houses are built with blocks of snow. The builder stands inside and carries the blocks of snow around in an upward spiral, fitting them together with a large knife. The tops of the blocks are inclined toward the center in such a way as to form a hemisphere. At the top a block is fitted in, which acts as a keystone. Windows are sometimes made of clear ice set in the snow wall. Such houses are durable as long as the weather remains cold. They can be made practically airtight by filling the cracks with snow. Heat is provided by a lamp which burns blubber and serves for cooking as well as heating. It is only in the Arctic that continuous cold for months makes such material feasible for house building. On the other hand, if the Indians of the Southwest had the skill and knowledge of the Eskimo, they might build permanent water-tight roofs of soft sandstone with arches or domes held in place by a keystone.

South of the Eskimo, in Canada east of

the Rocky Mountains and in the United States between the mountains and the Mississippi River, were hunting tribes who followed the game. They had conical dwellings consisting of poles slanting to an apex from a circular base. These poles were secured by tying at the meeting place above. They rested either on a tripod of similar poles or two pairs of poles tied together and erected first. The covering of these tents in pre-Columbian times was chiefly of skins dressed and sewed together. In the north the skins employed were those of the caribou which are very white when new. In the south the skins of buffalo cows were employed. The tipi standing in the Plains Indians Hall of the American Museum is made of the skins of domestic cattle, but there are in the Museum's collections two covers of buffalo skin.

In the New England states and eastern provinces of Canada, birch bark was sewed into wide strips and these were wrapped around a similar frame work of poles. This bark could be rolled up and transported in canoes or on sledges, and new poles cut almost anywhere. On the great plains suitable poles were secured with difficulty. They had to be sought in the mountains and carried long distances. When the camp was moved the poles were dragged to the new site. This was done in early times by dogs and later by horses.

The Iroquois Indians of New York State were and still are strongly agricultural. There is fair reason to suppose they came from the south and brought with them certain southern traits such as the use of the blow gun. They counted their descent through the mother and were grouped into clans. Their houses are known as "long houses," being in some cases 100 feet long. The width was moderate, being about 17 feet. A passageway ran straight through the middle with compartments on either side opening into it. There was a row of fires running through the center, so placed that four compartments were served by each fire. The people occupying such a house were related to the matron who controlled the house, either as married sons or married daughters. These houses had frames of

Photograph by Macmillan

REPAIRING THE WINDOW OF AN IGLOO

The Eskimo seem to have been the only American natives who possessed the skill and knowledge to build houses with arches or domes held in place by a keystone

poles and were covered with elm or oak bark. Such houses were common in the seventeenth century and a few were built late in the eighteenth century.

Pawnee on the Platte. The houses of these Indians are known as earth lodges, since the roofs are dirt covered. The main frame consists of four large posts set firmly

American Museum of Natural History

A MICMAC WIGWAM

Wherever birch bark was plentiful, the conical houses of the Algonkian Indians of New England and Canada were covered with the bark sewed to form long strips. The wigwam illustrated, which is now in the Eastern Woodland Hall of the American Museum, originally housed a Micmac family

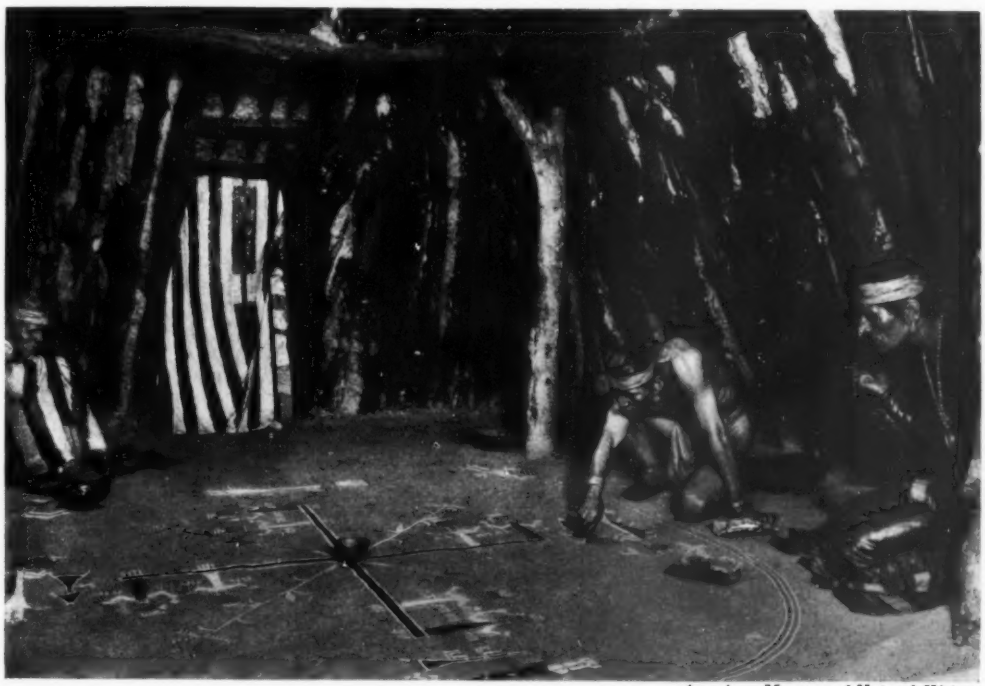
The houses of the Virginia Indians were also long and narrow and were occupied by several families. We know them from the drawings made by John White in 1585 and from the description given by John Smith. The frame of the house was made of bent poles lashed together so that the roof was vaulted. The covering was composed of mats or bark.

Not all the tribes on the great plains lived exclusively by hunting. Certain tribes had villages along the Missouri and the Platte rivers where rather extensive corn fields were cultivated by the women. Among the best known are the Mandan, now nearly extinct, the Hidatsa, the Arikara on the Missouri, and the

in the ground. The tops are joined by beams and on these the upper ends of the rafters rest. The outer ends of the rafters are supported on poles which in turn rest on forked posts set around the outer wall of the house. The roof is first covered with poles and brush and then with earth. The houses of the upper Missouri region were large enough to accommodate several families. The favorite horse was sometimes stabled in the house at night to guard against theft. Some of these houses had their earthen floors excavated to the depth of three or four feet. Houses of this sort are entered by a ladder through the smoke hole which is in the center of the roof. The houses in the Thompson River

INDIANS OF THE EARLY WEST

This interior of a Mandan house is reproduced from an engraving by Carl Bodmer, a Swiss, who accompanied Maximillian, Prince of Wied, on his visit to the Missouri River in 1832-34. The framework of four posts and cross beams supports the roof. Note the two horses sheltered within the house



American Museum of Natural History

A CEREMONIAL LODGE

The interior of a Navaho house built for conducting a ceremony. A sand painting is being constructed with dry colors. It represents a whirling log, on the ends of which pairs of divine beings are sitting, and from the angles of which stalks of corn are growing

region are of this semi-subterranean type.

Along the Pacific coast from northern California to the Alaskan Peninsula, houses were built of split planks. The houses of the Klamath River region had the roofs in three sections, the uppermost one being nearly flat. The end and side walls were of planks stood on end, and the roof of planks ran from the eaves to the ridge. A pit was excavated to considerable depth and lined with hewn planks. These houses were for single families, being about 20 feet square; the excavated part, which was the room available for living purposes, was about 12 feet square.

About Puget Sound were again multiple houses. These were rectangular and were placed with one long side, the higher one, facing the stream or beach. The back side was lower so that the roof sloped from the front to the back. One house, no doubt an exceptional one, is reported to have been 60 feet wide and 520 feet long. Such a house was partitioned with hung mats so that each apartment was a cross section with its separate house fire. The walls were of split planks placed horizontally and held in place by lashing them between two poles. The roof planks were curved and laid reversed and overlapping like tiles.

Farther north along the coast the

HAIDA HOUSES

These houses at Tanu, Queen Charlotte Island, British Colombia, which are now falling into ruins, show excellent examples of totem poles and their use in connection with the houses. The lumber used for the houses was obtained by splitting red cedar logs and smoothing them with chisels and adzes

A WINTER SCENE

This picture, also by Carl Bodmer, represents a group of earth lodges in a Hidatsa winter village

houses had a very different structure. The main frame consisted of four posts in two pairs, the pairs being separated by the depth of the house. On these pairs of posts rested two long, large, round beams which supported the roof of the house. In earlier times the end and side walls were of split planks placed horizontally. More recently the planks have been placed upright. Such houses as these of the Pacific coast required a great deal of hand labor to fashion the lumber and erect the house. The owner would accumulate property for some years before beginning, and then, after the frame was up, he would discontinue the work while enough wealth was obtained to provide the walls and roof. The four supporting posts were usually carved and a tall pole was erected in front of the houses of the nobles. These are the totem poles for which the region is famous. The poles standing outside had the coat of arms of the husband and wife or some incident from the ancestral myth carved on them. Such a house held one principal family and several dependent ones and was controlled by a house chief.

It is in the Southwest, in Arizona, New Mexico, and southern Colorado and Utah, that the most remarkable dwellings are found. The crowning period in Southwestern architecture was sometime before the Spaniards entered that region in 1540, probably some centuries before. These structures may be divided into two classes according to whether they stood in caves under overhanging cliffs or were in the open. In either case the walls were of stone and the ceilings or flat roofs were of beams covered with poles, brush, and trampled clay. These cubical rooms were joined to each other and superimposed on one another, so that a vast structure was formed with several stories, the upper ones terraced back.

Of those standing in caves, the Cliff Palace of Mesa Verde is one of the largest.

Courtesy of the Museum of the American Indian

A SANTA CLARA WOMAN AT HER DOORWAY

The men of Santa Clara usually set up the framework and lay the bricks. The women do the plastering inside and out, their hands being their chief tools. This was true in the days of the cliff dwellers, for the finger-marks of the women still remain on the walls

Courtesy of the Museum of the American Indian

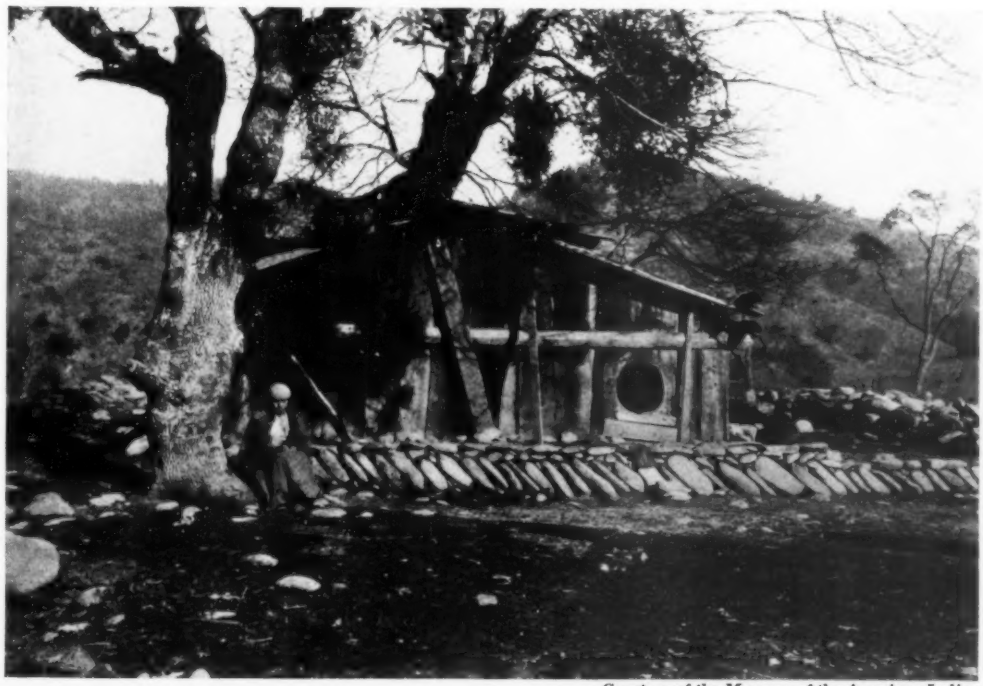
AN APACHE HOUSE

In Arizona a fairly simple house answers every purpose of the Indians. At night they feel quite secure if shut in from view, and their days are spent out of doors. They have but little to store away, and the corn after harvesting is kept in pits dug at some distance from the house

Courtesy of the Museum of the American Indian

A NAVAHO HOGAN

The Navaho Indians of New Mexico and Arizona live during the winter in more or less conical houses covered with earth. There is a large smoke hole in the roof and a door toward the east. These houses are permanent until some one dies in them; then they are abandoned



Courtesy of the Museum of the American Indian

A HUPA HOUSE

In northwestern California, houses of this type were built. The doorway is circular, made small enough to prevent the entrance of grizzly bears. A room smaller than the house itself, excavated in the ground within the frame shelter, serves as the real living quarters

The cave is 425 feet long and 80 feet wide at the widest part. The building has 117 ground-floor rooms. The walls are of well-dressed sandstone laid up in adobe mortar. The buildings standing in open country are designed with a view to defense. They are usually built around a court back from which they are terraced, the exposed outer wall being sheer and practically unpierced with doors or other openings. The ruin known as Aztec, explored by the American Museum, is 359 × 280 feet, the court being 200× 180 feet. The individual rooms are quite small, so that a large population was accommodated in such a building. Another notable ruin is called Pueblo Bonito, and is situated in Chaco Cañon, New Mexico. It is semicircular in ground plan, terraced back from the court to a high curved outer wall. In the case of both these ruins the court was protected by a row of rooms closing the exposed side. It appears that these buildings were not designed and built at one time. The general plan was laid out and then the buildings were extended as more space was needed. In the case of Aztec there were two periods of occupation, the first by people from the south related to the Chaco Cañon people and later by a people from the north who were connected with Mesa Verde, where the Cliff Palace is situated.

At the present time there are similar buildings, known as pueblos, which house the Indians of this region. Those in New Mexico are scattered along the Rio Grande; one, Acoma, is on a high mesa; Zuñi is on the headwaters of the Little Colorado near the Arizona line. In Arizona are three mesas on which stand eight Hopi villages. These are built much like the pre-Spanish pueblos, but with less care and skill.

Such close living is accompanied by a

LIFE ON THE PLAINS

A rendering by Bodmer of the home of an Assiniboin chief. Dogs are shown with travois, primitive contrivances for transporting property without the use of wheels

AN ENCAMPMENT

Another picture by Bodmer showing a village of skin-covered tipis. A hunting party is returning, the spare horses laden with buffalo skins and probably also with meat

closely knit social organization and a well developed political system.

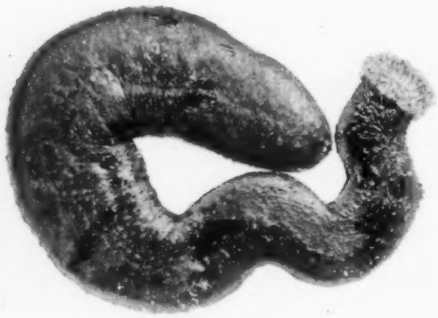
By no means all the varieties of dwellings have been mentioned, but a considerable range in material, size, and architecture has been demonstrated. It is also striking that there is no common element which is characteristic of American dwellings that may be cited as a common bond of unity. There is the lack of keystone arches in stone and the entire lack of chimneys, but then, even chimneys in the present sense were unknown in Europe in the Middle Ages.

A THOUSAND MILES OF CORAL REEF

The Marvelous Natural Structure Built by the Lowly Coral Animals and Known as the Great Australian Barrier Reef

By ROY WALDO MINER
Curator of Marine Life, American Museum

WHEN Columbus aroused Europe by demonstrating that the ocean, far from setting a barrier to man's conquest of the globe, was actually an avenue to hitherto unknown lands of continental vastness in the West, the vision of European navigators, suddenly expanded by his discoveries and the subsequent voyages of Vasco da Gama, Balboa, and Magellan, pictured beyond the vast oceans traversed by them, the shadowy form of a great southern continent, or Terra Australis, balancing the globe in the neighborhood of the Antarctic Circle. During the fifteenth century, these imaginings apparently resolved themselves into persistent tradition, due perhaps to rumors of Spanish and Portuguese sailors wrecked or escaping with difficulty the complicated reefs and shoals of a vast shore south of the Indies. In the following century, Dutch vessels setting forth valiantly to extend their East Indian trade, stumbled upon the northern Australian shores, and soon many miles of the western coast were known to their vessels. The English followed hard on the heels of the Dutch, but during the seventeenth and most of the eighteenth centuries, New Holland, as it was called, was a vast region of unknown extent. It was not till 1770 that the eastern coast was discovered by Captain James Cook. He was sent out by the British government with a definite commission to test the existence of a great south Pacific continent, and after charting many of the oceanic archipelagoes of the South Seas, he reached Australia and discovered its eastern coast. We have him to thank for our first knowledge of that remarkable coral formation known as the Great Barrier Reef of Australia, by no means the least marvelous of the many natural wonders of that amazing island continent. It is by far the largest barrier reef in the world, extending for more than 1250 miles along the eastern shore of the mainland. It is entirely included within the boundaries of Queensland, and aside from its interest as a natural feature, the products associated with the reef form a commercial asset of no mean importance for that colony.



After Saville-Kent

A TYPICAL SPECIMEN OF BÊCHE DE MER, OR TREPANG

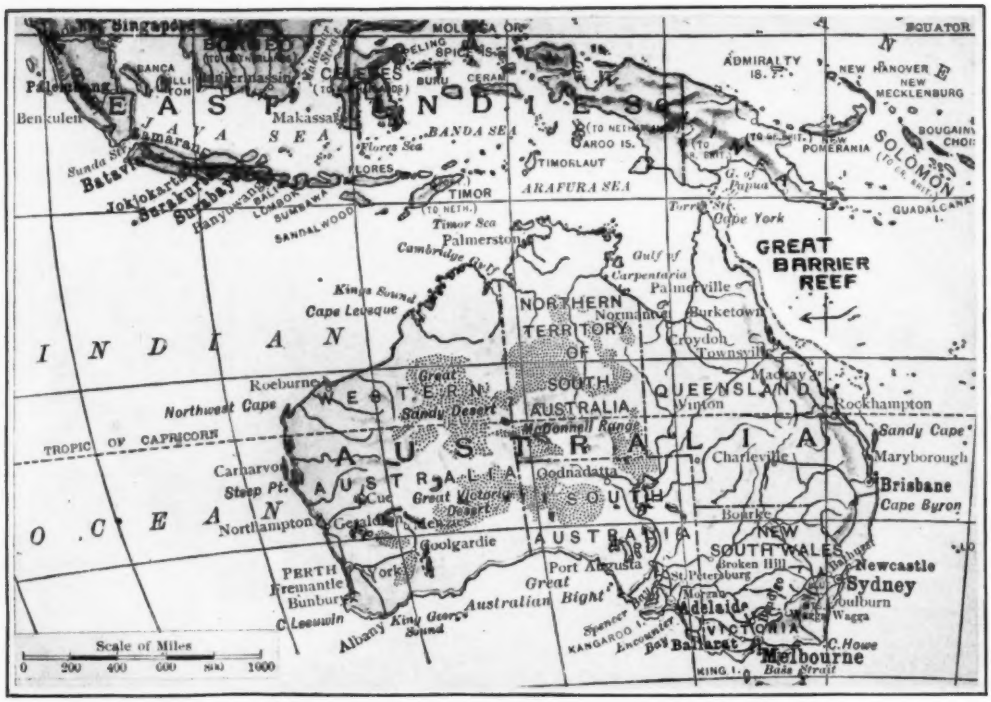
This species, the snakelike bêche de mer (*Holothuria coluber*), though not itself greatly sought for, is closely allied to several species of commercial value, and illustrates well their general appearance. Its leathery, snakelike body may be a foot and a half or two feet in length, and is covered with wartlike papillæ, which may be extended as "tube-feet," to aid it in locomotion. At one end may be seen the brushlike tuft of oral tentacles, by means of which it secures its food

Australia itself, as everyone knows, is the only great continental division situated

After Saville-Kent

A TYPICAL VIEW ON THE GREAT BARRIER REEF AT PORT DENISON, ON THE NORTH QUEENSLAND COAST

A splendid example of coral barrier reef development as exposed at low tide. The circular expanded fronds of a beautiful madrepore (*Acropora conveza*) are everywhere evident, their surfaces closely crowded with serrate, steeple-shaped coral tips. These corals resemble spreading masses of flower-like bloom, the tiny steeples varying in color from rose through red-brown and green shades, all tipped with bright yellow. In the distance may be seen the quiet waters of the lagoon, and beyond rise the mountains of the Australian mainland



MAP SHOWING POSITION OF THE GREAT BARRIER REEF OF AUSTRALIA
This reef extends for more than 1250 miles along the eastern shore of Queensland

entirely within the southern hemisphere, being included comfortably between the tenth and fortieth parallels of south latitude, if one does not reckon in Tasmania. Thus Melbourne, its most southern port, corresponds roughly in latitude to Atlantic City, N. J., in the Northern Hemisphere, while its northern extremity, situated well within the tropics, is comparable to the island of Trinidad, off the coast of British Guiana.

In other words, if the continent of Australia were reversed and placed in a homologous position in the Northern Hemisphere, it would set neatly into place in the North Atlantic Ocean, with Melbourne in a line with Atlantic City, and Cape York north of Brazil and immediately east of Trinidad. The climate likewise corresponds with this situation, grading from equable temperate at Melbourne, to decidedly tropical as one proceeds northward. Two-thirds of the colony of Queensland is within the tropics, and it is along the coast of this portion that the Great Barrier Reef is situated.

The reef is entirely of coral formation; that is, it is built up of the limestone skeletons of coral polyps, the calcareous deposits in the tissues of corallines and other lime-depositing sea plants, the shells of mollusks, wind-blown coral sand formed by ground-up fragments of the above creatures, minute skeletons of semi-microscopic animals, the foraminifera, and, in the shallower warm lagoons, by direct deposition of carbonate of lime from supersaturated sea water. The operations of the reef-building coral organisms are carried on only in warm waters which average at least 68° Fahr., and from the low-tide mark to a depth of not more than twenty fathoms. Hence they are formed only on the shallow submerged margins of oceanic islands

and continents within the tropics and usually where they are exposed to prevailing winds and currents. These bring them in greatest abundance the microscopic organisms which form their food, while the boiling surf, dashing upon the outer reef, is well supplied with oxygen. In such exposed situations, likewise, the growing coral polyps are less likely to be choked by silt and sand. Hence they grow most abundantly on the outer margins of the oceanic shelf and tend to form a living barrier awash at low tide, parallel to the land, and at some distance from it. The barrier is always separated from the mainland by a channel or lagoon, floored by the more slowly growing corals.

In the case of the Great Barrier Reef, this is a continuous waterway, beset, it is true, by complicated shoals, but nevertheless navigable for ocean-going vessels throughout its entire length, provided they are guided by skilful pilots. The Australian government maintains an efficient system of lights and channel markers for the benefit of mariners. The distance of the reef from the coast varies from a minimum of about ten miles at Cape Melville to more than a hundred miles at the northern and southern extremities, where it bends away from the coast. The average distance of the northern half, however, is quite constantly between thirty and forty miles, while farther south it approximates sixty miles, gradually attaining the maximum distance toward the southern end. It is manifest that the

After Saville-Ken

A SCENE ON SKULL REEF AT LOW TIDE

This islet, situated on the outer barrier, is uncovered only at low tide. It has received the name Skull Reef because the many dome-shaped corals exposed, belonging to the genus *Goniastræa*, have a superficial resemblance to bleaching skulls of giant human beings

After Saville-Kent

NATIVES OF WARRIOR ISLAND PREPARING BÊCHE DE MER FOR THE CHINESE MARKET

This island, situated in Torres Strait, is one of the most important centers of the bêche de mer industry. Fleets of native schooners, fishing along the reefs, bring in cargoes of bêche de mer, which the natives boil in huge kettles like those seen in the background. The bêche de mer are then taken out, slit open, and the viscera removed, after which they are dried in the sun. Finally they are taken to the smokehouse where they are thoroughly cured and prepared for packing for transportation to Hong Kong and other ports. They are much desired as the basis for a soup which is considered a great delicacy

lagoon or protected body of water enclosed by this enormous reef must be of considerable area. In fact, Saville-Kent estimates it at more than 80,000 square miles.

The reef itself is not a continuous wall at the water's surface, but is really a series of countless reefs. The outer line of the main reef is broken by channels, while immediately within are numerous secondary reefs forming parallel lines with the outer barrier. At intervals are channels or passageways, a few of which are well known to mariners as passable for larger vessels.

Occasionally islets of various size occur, formed by coral fragments heaped up by storms until they have projected sufficiently above sea-level to entangle sand and silt and to retain the seeds of various terrestrial plants until a growth of vegetation has been established.

Within the reef the waters are calm and peaceful during the greater part of the year, but outside, the restless surf of the Pacific dashes against the Barrier, and the combination of winds, strong tides, and cross currents renders navigation dangerous. Even in the quiet waters within the reef are many lurking perils due to concealed shoals and "niggerheads," and it is necessary to maintain a careful lookout. The intrepid Captain Cook learned this to his cost, for his account of his careful exploration of the coast-line is filled with incidents of perilous negotiations of narrow passageways in the reef, of running

aground under difficult circumstances, and of damages to his doughty vessel, the "Endeavour," which would have amounted to shipwreck, were it not for the resourcefulness of skipper and crew, and their skill in repairing their craft.

The vast majority of the reefs are submerged or exposed only at the lowest tides. The channels between these form a veritable labyrinth, and the magnificent sea-gardens with which they are floored tempt the visitor to forget the difficulties and perils of navigation.

The exposed portions of the reefs, especially those that are storm-beaten, are not particularly attractive from the viewpoint of the naturalist interested in coral growths, but the more sheltered locations are remarkable for the beauty of their fauna, especially those open to free circulation of the incoming waves without being exposed too greatly to their destructive influence. The journal of Professor J. B. Jukes, naturalist for H.M.S. "Fly," which explored the reefs from 1842 to 1846, may be quoted here:

In a bight on the inner edge of this reef was a sheltered nook, where the extreme slope was well exposed, and where every coral was in full life and luxuriance. Smooth and round masses of Mæandrina and Astræa were contrasted with delicate leaflike and cup-shaped expansions of Explanaria, and with an infinite variety of branching Madræporæ and Seriatoporæ, some with mere finger-shaped projections, others with larger branching stems, and others again exhibiting an elegant assemblage of interlacing twigs of the most delicate and exquisite workmanship. Their colours were unrivalled—vivid greens contrasting with more sober browns and yellows, mingled with rich shades of purple, from pale pink to deep blue. Bright red, yellow, and peach-coloured Nulliporæ clothed those masses that were dead, mingled with beautiful pearly flakes of Eschara and Reteporæ; the latter look-

After Saville-Kent

MADREPORE AND PORITES CORALS GROWING LUXURIANTLY ON A PROTECTED CORAL REEF

They are shown as they appear when laid bare by the lowest tides. If exposed too long the corals die, and their skeletons become bleached to a snowy white. While living, the animal layer of each coral frond clothes it with glowing color, which varies in the different species, and even within the same species, so that a luxuriant reef resembles a garden of marine flowers

Photograph by Saville-Kent

RAISED CORAL REEF COVERED WITH VEGETATION

When coral masses have been heaped up by wave action or raised through geologic agencies, islets are formed upon which seeds of tropical plants take root. Thus a growth of vegetation is started, which soon becomes established and fits the newly formed land for human habitation. Australian natives with a dugout canoe are shown in the foreground. For a long time such natives were used as divers in the pearl fisheries of Australia. More recently they have been replaced by Japanese

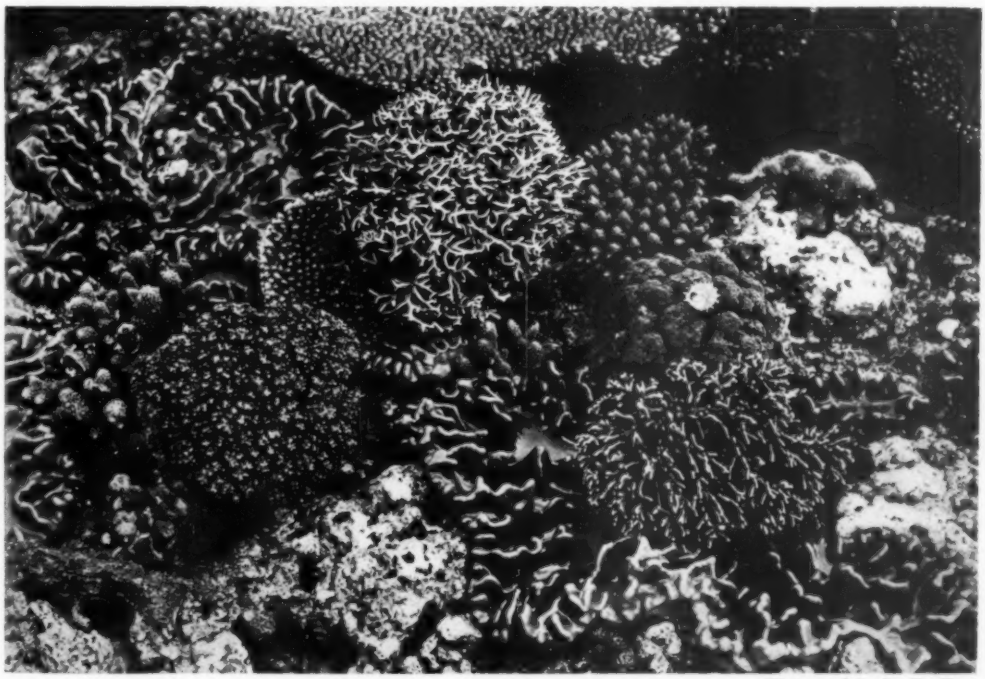
ing like lace work in ivory. In among the branches of the corals, like birds among trees, floated many beautiful fish, radiant with metallic greens or crimsons, or fantastically banded with black and yellow stripes.

Saville-Kent, in his monograph on the Great Barrier Reef, states that even on the sides of the reef exposed to the breakers at the lowest tide mark, delicate and apparently easily injured species are found flourishing beside the more robust types. This accords with my own observations on the outer and most exposed side of the Andros barrier reef in the Bahamas, where, with the aid of the Williamson submarine tube, we sat on the floor of the sea, at depths ranging from fifteen to thirty feet, and saw the most luxuriant growths of delicate and fragile branching corals growing around and in front of the giant trees of the palmate elkhorn coral. This was outside the windward face of the reef, on the verge of a precipitous drop to a depth of one thousand fathoms. Doubtless if one could descend the face of the Australian barrier below the force of the breaking surf, similar conditions would be found. Very likely, associations of coral would occur comparable to those described by Saville-Kent, as seen by him in more sheltered portions of the reef that were permanently submerged. "Their sloping edges," he says, "down to a depth of three or four fathoms, as seen on a calm day over the boat's side, often reveal terrace upon terrace, or literally hanging gardens, of coral growth of every form and color. . . . One almost perpendicular bank may be almost completely covered with the spreading vasiform coralla of *Madrepora surculosa* or *pectinata*, usually

of a pale-lilac or pink-brown hue, with pale-primrose or flesh-pink growing edges. . . ."

Another bank may "include robust branching staghorn varieties, resplendent with intermingling tints of electric-blue, grass-green, and violet. . . ."

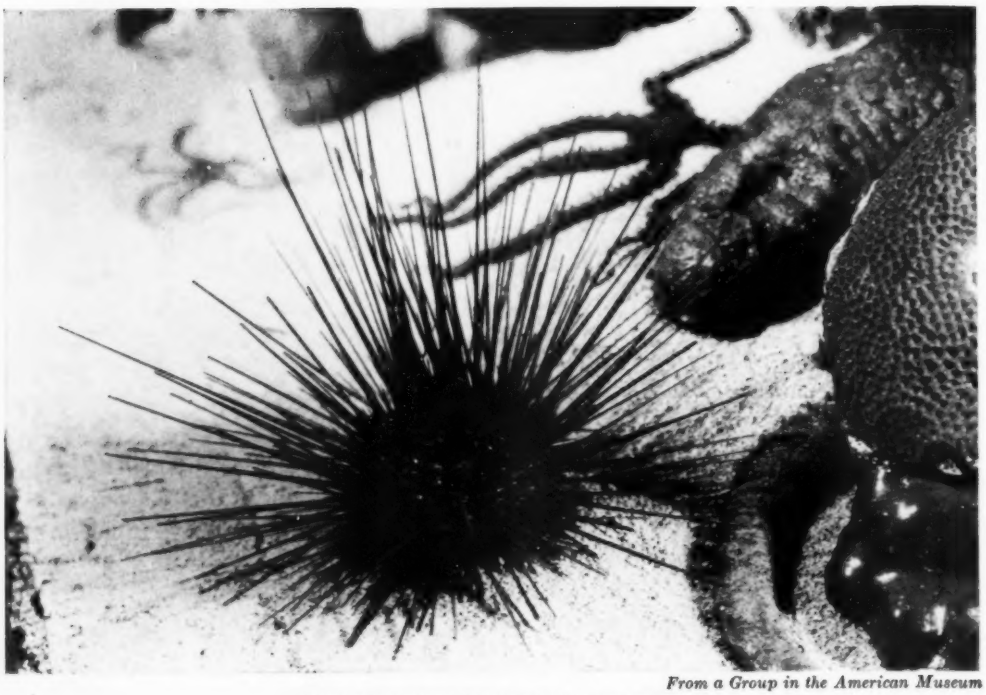
In the pools and submerged crevices are many remarkable forms of life, living in association with the coral growths. Sea anemones, varied in form and brilliant in color, exist in large numbers, spreading their living flower-like discs to suggest gardens of dahlias. Some of these have subdivided, fernlike tentacles capable of giving a powerful, burning sting, producing a rash on the skin like that of nettles, which will remain several days. The giant sea anemone (*Discosoma haddoni*) has an enormous disc, a foot and a half in diameter, covered over with thousands of spherical, beadlike tentacles mounted on tiny stalks. These tentacles are green or purple, while the mouth region is brilliant orange. A species of fish (*Amphiprion bicinctus*), brilliantly red, with two conspicuous white bands surrounding the body, lives in the stomach cavity of the anemone, and swims out from time to time, returning immediately to its shelter within the stomach of its host. It is suggested by Saville-Kent that this commensal partnership between these very diverse animal forms is of benefit to both in this way: The brightly colored fish acts as a lure to other larger species, which dart to seize it and are immediately stung by the anemone and appropriated for food. The fish partner meanwhile is protected by its host and possibly shares



Photograph by Saville-Kent

DETAIL SHOWING TYPICAL REEF CORALS

Pocillipores, galaxea, madrepores, and nullipores are represented. These are various genera of reef-forming corals, except the nullipores (sea plants), the cells of which are impregnated with calcareous material, and superficially resemble coral growths. The symmetrical clusters of finely branching white filaments in the upper center and lower right of the photograph belong to this group of sea plants, which are important factors in reef formation



From a Group in the American Museum

THE SLENDER-SPINED SEA URCHIN
Diadema setosum

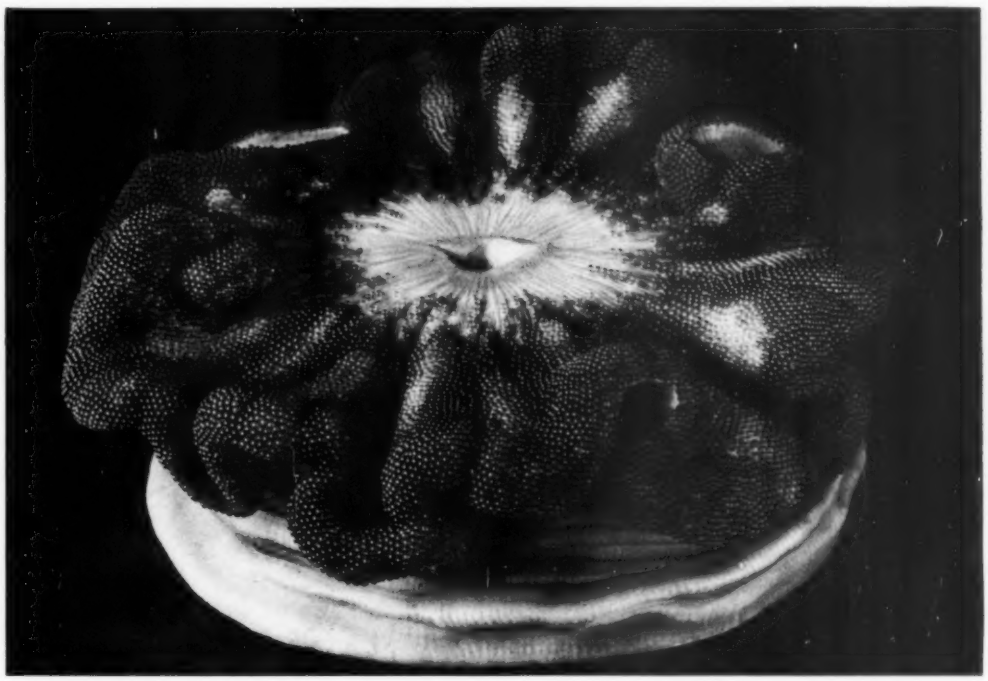
A common inhabitant of coral-reef lagoons throughout the tropical waters of the world. Its needle-like spines readily pierce the feet or ankles of the unwary wader. Near by may be seen a brittle-star. [and the elongate, leathery body of a bêche de mer, or sea cucumber

fragments of the prey. It is never harmed by the stinging cells of the anemone. Some individuals of this species of anemone entertain as guest a little transparent prawn of the genus *Palæmon*. Like the fish, it has brilliant red markings, but fish and prawn are never found in the same anemone. There is a still larger anemone (*Discosoma kenti*) measuring two feet in diameter, covered with golden-brown and blue tentacles, tapering in shape. This species is also host for a fish (*Amphiprion percula*), vermilion like the other species, but with three white bands instead of two. Sea urchins, sea stars, and sea cucumbers are abundant among the corals. The former includes the ubiquitous slender-spined urchin (*Diadema setosum*), found all over the world in tropical waters. Its long, needle-like spines menace in all directions, and, at the slightest touch, pierce the foot or ankle of the unwary wader. Another sea urchin, the slate-pencil urchin (*Heterocentrotus mamillatus*), has thick, cylindrical spines, blunt at the tip, strongly suggesting those implements useful to the school boy of a past generation. Sea stars, scarlet, blue, or brown, also give diversity to the reef. The giant sea cucumber (*Synapta beselii*) coils its knobbed, orange-colored convolutions through the crevices of dead coral, expanding a graceful feathery crown of tentacles like a passion flower. Green, brown-spotted, and orange bêche de mer stretch their fringed and papillate bodies over the sand like decorated sausages, mopping up food particles from the sea bottom with their brushlike tentacles. One species of bêche de mer (*Holothuria mammifera*), mottled gray and black, acts as a commensal host to a small

tapering fish of the genus *Fierasfer*, which inhabits its branchial cavity. These are but a few of the remarkable creatures common in the Great Barrier Reef.

The most valuable products of the Great Barrier Reef from a commercial standpoint are pearls and pearl shell, bêche de mer, oysters, and food fishes.

Australia possesses the most extensive pearl-oyster grounds in the world. The most important fisheries are those of Queensland and Western Australia, said to be of about equal value. The Queensland fisheries have their principal headquarters at Thursday Island, in Torres Strait, which separates Cape York, the northernmost point of Australia, from the southern coast of New Guinea. To reach this strait from the Pacific it is necessary to pass the dangerous ramparts of the extension of the Great Barrier Reef which sweeps northward, nearly to the New Guinea shore. After the reef is passed, the funnel-shaped entrance of the strait is found to be practically choked with thousands of islets and reefs separated by tortuous channels, only a few of which are navigable to large vessels. The safer entrance is by way of the ship channel inside the Barrier Reef from the south, along the Queensland coast. By pursuing this route, after leaving Cooktown, as one sails northward, the vessel passes through the eastern portion of the pearl fisheries grounds, which are practically continuous from here around the peninsula of Cape York, along the entire northern coast of Australia, and down the western coast to



THE GIANT SEA ANEMONE OF THE GREAT BARRIER REEF

Discosoma haddoni

This photograph is from a life-size model in the American Museum of Natural History. The great flower-like disc of this creature is a foot and a half in diameter, and is covered with thousands of bead-like tentacles, varying from purple to green in color. These are armed with sting-cells which slay or stupefy fish or small sea-animals which form its food. One species of fish (*Amphiprion bicinctus*) brilliantly banded red and white, is immune to the stinging organs of the anemone, and lives within the creature's stomach, swimming in and out of its centrally located mouth at will

RELIEF MAP OF TWO SMALL PACIFIC ISLANDS OF THE SOCIETY GROUP, RAIATEA AND TAHAA, SHOWING THE BARRIER REEF BY WHICH THEY ARE SURROUNDED

The coral animals lay down deposits of limestone beneath their bodies. These deposits form branching or leaf-shaped expansions, or dome-shaped masses, according to the species. They accumulate on the submerged banks of islands and continents in tropical seas. At first these form fringing reefs close to the shore, but later they form a barrier reef paralleling the coast at some distance, enclosing a channel or lagoon between it and the shore. In the map a lagoon or channel is visible between the barrier reef and the islands, while a narrow fringing reef is seen close to the shore. The Great Barrier Reef of Australia is formed in a similar way, but on a vastly larger scale. It extends for 1250 miles along the Australian shore, and the enclosed channel varies from ten miles to more than a hundred miles in width. This map is on exhibit in the American Museum

Shark Bay. The fisheries were formerly carried on by Australian natives under the supervision of whites. Later Malays, Cingalese, and Pacific Islanders were extensively employed, while Japanese were gradually brought in increasing numbers, until now they predominate, and, in fact, practically monopolize the industry. This, doubtless, is due to their characteristic efficiency. In 1905, according to Dr. George F. Kunz, the Queensland fishery employed 348 vessels and 2850 men, while the commercial value of pearls and pearl shell harvested was about $675,000; that of Western Australia, about $958,000; and that of Southern Australia (also carried on on the northern shore of the continent), about $125,000. Thus the entire Australian pearl industry yielded about $1,778,000 in that year. These figures fluctuate and, in recent years, the output has decreased due to the exhaustion of many of the beds.

The Australian pearl oysters belong to three species, of which the largest and most valuable (*Margaritifera maxima*) is known commercially as the "silver lip," because of the silvery white iridescence over the entire inner surface. Next in value comes the "black lip" (*Margaritifera margaritifera*). This is characterized by a dark border around the inner edge of the shell. The third species (*Margaritifera carcharium*) is the smallest and least valu-

able, so far as its shell is concerned, but yields a higher percentage of pearls than the other two species. The "silver lip" shells yield the largest and finest pearls in the world, according to Doctor Kunz, while the shells themselves form the standard mother-of-pearl of commerce. Their annual value is several times that of the pearls found in them, in spite of the quality of the latter.

The pearl shells were originally secured by employing nude divers, who became very skilful in the very laborious and perilous art of diving, often to depths of sixty feet or more, to return to the surface with one or two shells at a time, or, more frequently, with none at all. The average time spent by a diver under water was fifty-seven seconds to a minute, though some South Sea natives have been known to remain under for nearly three minutes. In some cases, the diver would take a stone attached to a cord as a weight to carry him down more quickly, but in most cases he would dive feet first, turning head downward after descending a short distance and swimming the rest of the way. A few seconds only would be spent at the bottom groping for a shell or two. These would be placed in a fiber basket or secured under the arm, and then the diver would spring toward the surface. As long as he held his breath he would shoot upward rapidly, but if he failed to gauge his time accurately and let his breath go before reaching the surface, he would sink again, and, if not rescued, would be lost. Many such fatalities inevitably occurred during the course of the fishing. More recently, however, diving

After Saville-Kent

WRECK OF THE MISSION SCHOONER "HARRIER"

This vessel, belonging to the New Guinea Mission Service, was wrecked not far from Cooktown, on one of the many reefs, hidden except at low tide, which render the passage of the inner channel dangerous. On this occasion the crew of the vessel was rescued without loss of life. Many ocean-going vessels of considerable size have not been so fortunate, for hundreds of lives have been lost and much treasure has gone to the sea-bottom in the attempt to navigate the intricate channels of the Great Barrier Reef. The Australian government has installed many lights and markers to increase the security of vessels passing the channels

After Saville-Kent

OUTER BARRIER REEF SHOWING LIVING BÊCHE DE MER CRAWLING ON THE SEA-BOTTOM

The bêche-de-mer, or trepang, is a sea cucumber with leathery skin, furnished with many "tube-feet" along its outer surface, each equipped with a terminal sucker. By means of these organs the creature drags its body over the sea-bottom, mopping up the sand particles and the minute creatures clinging to them, which form its food. This is accomplished by a brushlike circlet of tentacles surrounding the mouth at the forward end of the body. The bêche de mer, when extended, may reach a length of from eighteen inches to two feet. Native fishing schooners may be seen in the distance fishing for these animals, which are cured and prepared for the Chinese market. The species shown in the above picture is popularly known as the "ordinary red-fish" (*Actinopyga obesa*), one of those most sought for commercially

suits of various types have been employed, and these are now generally used, thus decreasing the danger, and promoting much greater efficiency in collecting the shells. On the other hand, more effective methods and the rapid increase in the number of pearling luggers employed, especially by the Japanese, have resulted in the depletion of the beds, and some of the fleets have been drawn away to the Philippines and other regions.

The bêche de mer industry is a peculiar but profitable one. These animals, which are also called trepang by the Malaysians, are large sea cucumbers belonging to the family Holothuridæ. As stated above, they somewhat resemble huge sausages lying in shallow pools or lagoon bottoms among the coral reefs. Several species are used, readily characterized by their coloring or markings, or by surface projections of various types. As they are echinoderms, their leathery body is provided with numerous "tube feet," slender appendages terminated by sucker-like discs. These organs are arranged in five bands along the sides of the body and enable the animal to pull itself along the sea bottom. At one end of the creature is a circular mouth surrounded by a fringe of tentacles, by means of which the animal's food is secured. This consists mainly of Foraminifera, microscopic animals possessing a chambered, calcareous shell.

The holothurian obtains them by mopping its tentacles back and forth over the sand. These pick up sand and the other particles with which the Foraminifera are entangled, and transfer them to the mouth in ordered succession, returning to the quest again in reverse order. The Queensland natives gather the trepang into sacks, wading in the pools among the rocks at low tide, or diving for them in deeper water. They are then immediately conveyed by a fleet of luggers to curing stations, where they are boiled for a time in large kettles. Next, they are cut open, dressed, and dried in the sun, after which they are transported to smokehouses, where they are smoked on racks of wire netting for twenty-four hours, over a fire of red mangrove wood. They are then in a thoroughly dry, shrunken condition, and are ready to be packed into sacks and sent to the Hong Kong market. They are highly prized in China, where they form the basis of bêche de mer soup. When this is properly prepared it has the reputation of being more delicious than turtle soup. There is also a considerable market for them in Australia, the Pacific Islands, and in American Pacific Coast cities. In Queensland, they form an industry ranking with the oyster fisheries in commercial value.

Several varieties of oysters grow in great abundance in the Great Barrier Reef region. The most important commercial species is the so-called common rock oyster (*Ostrea glomerata*). This forms the basis of an extensive and valuable commercial fishery comparable with that of the Virginia oyster (*Ostrea virginiana*) of the United States, with which it seems to be closely related. The fishery centers about the Moreton Bay district where the mollusks are dredged from submerged beds or are fished from oyster banks exposed at low tide. In the latter case they are also cultivated with success. The bank oysters appear to be the most profitable. The shells are attached to stones or dead oyster shells as a clutch, or the "spat" (young) frequently settle down on the shell of a species of whelk (*Potamides ebeninus*), which abounds in the neighborhood of the oyster banks. The whelk carries about with it a load of the young oysters, which are thus provided with free transportation to pastures new and advantageous, and therefore thrive exceedingly. As they increase in size and weight, the poor whelk's burden in life becomes overwhelming. Soon it can no longer maintain itself on the surface of the soft mud of the bank and so gradually sinks down to perish, forced into its grave by its thriving burden. Saville-Kent states that frequently the load of oysters borne by a living whelk weighs half a pound, while their downtrodden beast of burden weighs scarcely an ounce. This is so frequent an occurrence that entire oyster banks are known as whelk-oyster banks. There are several other species of oysters found throughout the Barrier Reef area but, for one reason or another, their commercial importance is not so great.

As might be expected, the food fishes of this remarkable and productive region are very numerous and greatly diversified. Even in Saville-Kent's time, the fish fauna of Queensland alone, including fresh-water and marine forms, had reached practically 900 recorded species, of which upward of one-third, or 300 species, are of definite food value. These, as would be expected from the tropical climatic conditions of the colony, largely belong to the Indo-Pacific fauna. Probably the most important commercially are the members of the perch family, of which more than seventy species are of economic food value. A splendid example of this group is the giant perch (*Lates calcarifer*) which reaches five feet in length and a weight of more than fifty pounds. It is an excellent food fish. The gayly colored sea perches of the family Serranidæ are especially

abundant in the neighborhood of the Great Barrier Reef, and include at least twenty species, most of which are highly esteemed from a culinary standpoint. Red mullets, sea breams, banded doreys, red rock-cods, tassel-fishes, and jew-fishes are common and, though unfamiliar to American readers, are nevertheless characteristic and important items on the Australian bill of fare. Types allied to our horse-mackerels, barracudas, yellowtails, and bonitos are of frequent occurrence, while flatfishes, herrings, and eels are also well represented in their Australian counterparts. These, and numerous other species render the Australian food fisheries of great economic importance.

The Great Barrier Reef, therefore, is not only a most interesting feature from the standpoint of the zoölogist and geologist, but its 1250 miles of reefs and lagoons form a veritable treasure house of natural resources for the great Commonwealth of the Southern Hemisphere.

NOTES

ASTRONOMY

IS THERE LIFE ON MARS?—Prof. Frank Schlesinger, director of Yale College Observatory, addressed the Amateur Astronomers Association, at a March meeting on the subject "Life on Mars." Doctor Schlesinger said among other things:

Though Venus sometimes approaches the earth more closely than Mars, we can observe the latter far better than any other planet. Recent intensive work on the planet has shown that the conditions there are not vastly different from those on the earth. At certain times and at certain places the temperature gets up to what we would call comfortable, though at the same places at other times the temperature must descend to that of our arctic winters.

The atmosphere of Mars is much thinner than on the earth, but the essential constituents are probably much the same. It is certain that the higher forms of life on the earth would not survive for more than a few minutes at most if transplanted without modification to Mars, but our lower forms of life could prosper there, and it is all but certain that from these, higher forms would develop. But these higher forms might not resemble those that we are acquainted with on the earth and might even be constituted in such a way as to lie outside of our imagination. It is probable that such higher forms of life would develop senses beyond the five that we are acquainted with here, and these senses might be of such a character that we are not only ignorant of them but could not understand them. An analogy to this is found on the earth itself. For instance, the manner in which homing pigeons find their way back after being transported a thousand miles in covered boxes seems to be beyond our comprehension. Furthermore, comparatively high forms of life have invaded portions of the earth which at first sight would seem absolutely impossible. For example, life of highly complex form has penetrated to the very depths of the ocean, where the conditions differ more from those in which we live than the latter do from the conditions on Mars. While it is probable that Mars is inhabited by forms of life one or some of which may possess intelligence equal to or greater than our own, attempts to communicate with such beings by radio or otherwise seem all but certainly doomed to failure.

At the meeting of May 3, four reels of astronomical motion pictures made at the Mount Wilson Observatory, near Pasadena, California, will be shown. These will illustrate the use of the instruments of the astronomer's work-shop, and will also show some of the wonders of the sky as seen through the largest telescope in the world.

At the May 17 meeting, Professor J. Ernest G. Yalden will speak on "Astronomy in Navigation," illustrated with lantern slides.

In continuation of the regular work carried on at the bi-monthly meetings, summer activities of the Amateur Astronomers Association will be undertaken in coöperation with the Nature Trail of theAmerican Museum at Bear Mountain, Palisades Interstate Park. An astronomical telescope will be available for use under the direction of Mr. William H. Carr and his associates with the occasional assistance of members of the society, whose lectures will be announced later.

BIRDS

DR. FRANK M. CHAPMAN returned to the Museum on April 10 from a winter on Barro Colorado Island. While there he devoted himself exclusively to field studies, focusing his attention on the nesting habits of the oropendola (*Zarhynchus wagleri*), a member of the oriole family. The present year completes Doctor Chapman's third season's study of this species, and he is now in possession of data which not only cover the habits of this species, but show its relation to other forms of life with which it is associated.

COMPARATIVE ANATOMY

A BABY SPERM WHALE (*Physeter macrocephalus*) nineteen feet long was captured and towed into the Gowanus Canal, New York Harbor, by some longshoremen on March 13.

When the tide receded, the animal stranded and died. The American Museum of Natural History bought it from its captors and had it brought by truck to the Museum, where it was placed in the Hall of Ocean Life. A cast was immediately made by members of the department of preparation and the whale was then dissected by Mr. Raven. The most important anatomical features observed were in connection with the respiratory apparatus. The interesting arrangement of the little understood nasal passages was studied and the right nasal passage, which had hitherto been supposed rudimentary, was found to be well developed, and its position beneath the spermaceti organ was established. The left nasal passage, on the other hand, proceeds from the blow-hole backward and downward on the lateral surface of the spermaceti organ. A report on certain details of the anatomy was made by Mr. Raven at the annual meeting of the American Society of Mammalogists held in Washington, April 12.

CONSERVATION

MADISON GRANT in a letter to the editor of the *New York Times* has called attention to the necessity for conservation of our forests, especially privately owned timber land included in our National Parks. He says in part:

What is left of our national heritage of forest must be carefully guarded. In the past, Americans have cheerfully squandered their natural resources of timber and wild life and are now entering upon a period where millions must be spent to restore what has been needlessly destroyed.

The sugar pine and the white pine of the Sierras are among the grandest trees in the world, ranking in majesty second only to the giant sequoias themselves. They are national monuments, and a wiser and riper civilization will regard their destruction as a shameful disgrace to the generation which permitted it.

EDUCATION

THE NATURE TRAILS AND TRAILSIDE MUSEUM at Bear Mountain on the Hudson will be open to the public from the first of May until the first of October. Mr. William H. Carr will represent the department of public education and will, for the second year, have charge of the operations.

Last season there were more than 23,000 visitors to these trails. It is hoped that this year the attendance will be doubled, due to the fact that the museum building will be open for the first time.

The trails and museum are located near the Bear Mountain Inn, and are within easy reach of the Bear Mountain Bridge.

EXPEDITIONS

CENTRAL ASIATIC EXPEDITIONS.—A cablegram from Dr. Roy Chapman Andrews states that despite the many handicaps caused by uncertain political conditions in China, the field staff of the Central Asiatic Expeditions left Kalgan April 14 to resume field work in the Gobi Desert. Prospects are bright for a successful season. The party includes Roy Chapman Andrews, leader Walter Granger, palæontologist, Alonzo W. Pond, archæologist, and Leslie E. Spock, geologist.

THE CARLISLE-CLARK AFRICAN EXPEDITION.—Through the generosity of Mr. and Mrs. G. Lister Carlisle, Jr., of New York, an additional group is being made possible for the great African Hall in the American Museum, of which Carl Akeley dreamed and to which he gave his life. Mr. and Mrs. Carlisle are greatly interested in the African Hall, and it was their desire to assist in the collection of African material that led to the formation of the Carlisle-Clark African Expedition, which leaves New York early in May.

The personnel of the expedition consists of Mr. and Mrs. Carlisle, Mr. and Mrs. Clark, Mr. R. C. Raddatz, preparator, and Mr. W. R. Leigh, artist. The plan is to spend about four months in the field, the party returning to New York the first of December. The expedition will reach Nairobi, Kenya Colony, East Africa, about the middle of June, and proceed directly to Tanganyika Territory for collecting.

Mr. Carlisle himself is an ardent photographer and is setting out for Africa well armed with both motion-picture and still-camera films.

In addition to the desired specimens and accessories specifically to be collected, Mr. Clark likewise is interested in obtaining valuable photographic records of the wild life to assist in the designing and modeling of the groups. Through his close association with Carl Akeley and his complete knowledge of the plans for the African Hall, Mr. Clark is eminently fitted to undertake the work. He has previously spent some time in Africa on two different expeditions and is thoroughly familiar with the habitats of the big game of the East Coast.

THE STOLL-MCCRACKEN SIBERIAN-ARCTIC EXPEDITION OF THE AMERICAN MUSEUM.—Curator H. E. Anthony, in charge of the scientific party of this expedition, left New York April 20, to join the schooner "Effie Morrissey" at Seattle. Mr. Harold McCracken, leader, E. M. Weyer of the

department of anthropology, and F. L. Jaques and A. Johnston of the department of preparation, accompanied him. Mr. and Mrs. Charles H. Stoll will join the party late in May in Alaska.

THE DEPARTMENT OF VERTEBRATE PALÆONTOLOGY is sending out three men, Peter Kaisen, Ernest Kaisen, and Glen Streeter, to coöperate with the Colorado Museum of Natural History, in completing the Folsom, New Mexico, bison excavations, noted because of the association of human artifacts with an extinct species of bison.

Miss Rachel Husband is to continue the search for Ft. Union mammals in a coal mine at Bear Creek, Montana.

J. C. Blick, Charles Falkenbach, and Joseph Rooney are to continue work in the Pliocene near Keams Cañon, Arizona, and Joseph Rak will continue excavations in the Pliocene at Santa Fe, New Mexico.

HALL OF OCEAN LIFE

THE BENSON MURALS.—The first four of a series of twelve mural lunettes in the Hall of Ocean Life of the American Museum of Natural History are to represent the historic and now defunct American sperm whaling industry. Sperm whaling, rather than right whaling, has been selected because of its great picturesqueness and its important place in discovery and in the growth of the nation. The sperm whalers of Long Island, Nantucket, and New Bedford voyaged for months and years on end throughout all the warmer waters of the globe during a period of more than a century and a half. Individual vessels not infrequently remained at sea throughout a course of three or four years, and their place in spreading a knowledge of the position and power of the then young Republic cannot be overestimated.

Quarter-sized cartoons for the four whaling panels have now been completed by the well-known marine artist, Mr. John Prentice Benson. The technical details have been supervised by Dr. Robert Cushman Murphy of the Museum staff, who spent a year on a New Bedford whaler during 1912–13. The third panel of the series, in fact, depicts the Brig "Daisy" which was subsidized by the Museum during the cruise referred to, and which captured twenty-seven sperm whales on the course of the voyage from Barbados to South Georgia.

The four paintings are designed to show the more important types of vessels employed by the Yankee whalers, as well as four characteristic stages in the adventure of hunt, capture, and disposition.

The first is a morning scene. The call from the masthead has been sounded. The boats have been lowered, and strong arms are bending double the oars as they pull toward the blowing school in the early morning light.

In the second scene, one boat is about to come to grips. The harpooner stands with the iron poised, while ahead of his boat a sperm whale is sounding, with its pointed hump just slipping beneath the choppy water.

The third painting shows the victorious whalemen towing home the dead leviathan while the noon-day sun beats down upon a glassy sea, and the sharks have followed their noses in toward the expectant feast of the cutting-in.

Finally, we have the boiling process, or the trying out of the oil. Against a quiet sunset the square-rigger lies with slatting sails hauled just aback, while the dense smoke of burning blubber-scrap floats away to leeward. This is the final stage in the disposition of the whale at sea. After the tried-out oil has been cooled and run down into the great casks below, the vessel once more starts cruising, with the mastheads manned for spouts.

HISTORY OF THE EARTH

THE DEPARTMENT OF GEOLOGY AND PALÆONTOLOGY is assembling machinery under the direction of Dr. Chester A. Reeds, for sectioning and polishing large specimens of fossils, rocks, and meteorites. The new equipment includes a large specially constructed band saw, two eighteen-inch polishing laps, each with a different speed, a buffing lathe with two wheels traveling at high speed, a frame for circular saws, and other accessories. When the installation is completed, the operation of the machinery will be in charge of Mr. Prentice B. Hill.—C. A. R.

MEETINGS OF SOCIETIES

The AMERICAN ASSOCIATION OF ANATOMISTS met Apirl 5–7, at Ann Arbor, Michigan. Dr. G. K. Noble presented a paper embodying recent results obtained in experiments on factors controlling tooth form in salamanders. He showed that a striking sexual difference of the teeth was determined by the presence of the male gonads which secreted a hormone controlling the form of the teeth in the male; also that it was possible by the transplanting of gonads to change bicuspid teeth into monocuspid ones. These experiments are of interest because of the light they throw on factors controlling tooth form in general.

THE AMERICAN SOCIETY OF MAMMALOGISTS held its tenth annual meeting in the United States National Museum at Washington, Apirl 10–14.

Of the forty-five papers presented, seventeen concerned the anatomy, habits, migrations, parasites, and utilization of whales.

Mr. William J. Morden, American Museum associate in mammalogy, delivered an evening lecture on the Morden-Clark Expedition across Central Asia. Other papers presented by representatives of the American Museum were "Life Zones on Mount Roraima" by G. H. H. Tate, "Parasites of the Whale" and "Notes on the Anatomy of a Baby Sperm Whale" by H. C. Raven, "Over-population among Microtus" by R. T. Hatt, and "Random Remarks on the Cetacea" by J. T. Nichols.

Members of the American Museum staff were well represented in a comprehensive exhibit of the work of the American Mammal Artists, which was held in connection with the meeting.

At the SIXTY-SIXTH MEETING OF THE GALTON SOCIETY, held March 2, 1928, Prof. William K. Gregory reaffirmed his belief that man is descended from a limb-swinging or brachiating type of anthropoid ape, broadly similar to the chimpanzee but much more primitive. He proved conclusively to all those present that the human foot is derived from a stage which he called biramous, partly because the big toe has an independent musculature from the others, also that the anatomical evidence points to an extremely long line of tree-living ancestors of the earliest pro-human stock.

As regards the hand of man, Professor Gregory believes that the thumb enjoyed a secondary enlargement and specialization for tool-making purposes.

Professor McGregor, one of the closest observers of various living forms of anthropoids, remarked that the reduction of the thumb in the anthropoid apes had been exaggerated and that the impression of the small thumb of the ape is partly due to the relative elongation of the fingers. He also showed that the ape thumb, even when reduced as in the case of the chimpanzee, is used in picking up small objects and can be trained to thread a needle. He agreed with Professor Gregory that the humerus (*brachium*) or upper arm bone of man is closely similar to that of all the anthropoid apes and nearly indistinguishable from that of the chimpanzee.

Professor Osborn read Darwin's original definition of the ancestors of man (*Descent of Man*, p. 164) as provided with pointed and movable ears and a tail. He reiterated the opinion which he has advanced for two years past that the human stock branched off from a common stock, known as the Anthropoidea or human-like animals, long before the specialized habits of the manlike apes had profoundly modified their anatomy. This separation probably occurred in Oligocene time, during the first world-wide period of aridity, in which the forest-living animals of all kinds doubtless gave off the plains and open country types. It happens that the great Shara Murun formation of Mongolia, which is extraordinarily rich in the bones of fossil mammals, belongs to this very Oligocene period, wherein, according to Osborn's theory, the separation between the so-called 'pro-dawn man' and the anthropoid apes took place. He stated that our Central Asiatic Expedition included two of the most expert fossil hunters in the world today, Mr. Walter Granger, chief palæontologist of the expedition, and Mr. Albert Thomson, both of whom had had unparalleled experience in discovering the smaller forms of mammalian life. The rarest fossil remains in the world, however, are those of the monkeys and apes; the remains of man are even more rare than those of his distant relatives. One of Chief Andrews' original objects in organizing the Central Asiatic Expedition was to discover traces of our human ancestors, near or remote, and the crowning achievement would be such a discovery!

Professor Gregory's paper was also discussed by Professor Tilney, who stated that he could not conceive of the evolution of the human brain from any type except an arboreal brain.

Professor Morton, of Yale University, discussed the four types of foot, tarsioid, simian, anthropoid, and human. His conclusion was that 'comparative analysis of primate feet not only dissociates basically the human type from the primitive and lower forms, but also it demonstrates a positive affinity between the human and anthropoid types—the anthropoid type representing the preceding stage in the course of evolutionary development of the human foot.

THE FOURTH INTERNATIONAL CONGRESS OF ENTOMOLOGY will be held at Cornell University during the week beginning August 12, 1928. Dr. Frank E. Lutz has been appointed as the official representative of the American Museum.

PROF. CHARLES P. BERKEY, research associate in geology of the Central Asiatic Expedition staff, has been invited to take part in an arranged discussion on the geology of Central Asia at the meetings of the BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, which will be held in Glasgow next September. Professor Berkey will attend the convention as an official delegate of the American Museum and of Columbia University.

SCIENCE OF MAN

Dr. Margaret Mead, assistant curator of ethnology, was granted a fellowship by the Social Science Research Council at its meeting on April 7. Doctor Mead intends to leave about September 1 for one of the Melanesian islands in the South Pacific, where she will study in particular the life of children in a primitive society. Doctor Mead made a study of girls on a Samoan island in 1925–26 before taking up her duties at the Museum. Miss Mead will return to her position in the department of anthropology after a year's leave of absence.

Wooden Shield Found at Chichen Itza.—At Chichen Itza, Yucatan—one of the most famous groups of Mayan ruins—the field party from the Carnegie Institution in Washington, under the leadership of Earl H. Morris, formerly with the American Museum, discovered a wooden shield, the surface of which is inlaid with tiny squares of turquoise. This shield was in the bottom of a jar, concealed in the earthen floor of the Temple of the Warriors, one of the more interesting buildings in the Chichen series. The find is said to be one of the finest examples of Mayan art. Unfortunately, the wood of the shield was decayed so that a restoration of the piece is necessary before it can be moved. In response to a request from the Carnegie Institution, Mr. S. Ichikawa, of the American Museum staff, has gone to Yucatan to make the restoration.

Archæological Work in Asia Minor.—At the request of Dr. James H. Breasted, head of the Institute for Oriental Research of the University of Chicago, leave of absence was granted in April, 1927, to Dr. Erich Schmidt of the Museum's department of anthropology, to take charge of the archæological excavation at "Alishar Hüyük," in central Anatolia, under Mr. von der Osten, the field director of the expedition. The only other Occidentals in the party were F. M. Blackburn, the topographer, a camp superintendent, and a carpenter. For nearly six months excavations were carried on in the huge "hüyük," or city mound, with an average crew of 120 Turkish laborers.

The method of American archæology which considers an obsidian flake as important as a sculptured rock, was applied in the Orient. As was to be expected, a great number of settlements and periods of occupation were represented at Alishar Hüyük. On the summit of "Mound A" which is approximately eighty-five feet high the Romans were the last occupants. Their houses were built on top of a pre-classical citadel where were found seals with Hittite hieroglyphs. In the domiciliary mound, traces of the successive Byzantine, Seldjuk, and Osmanli occupations were discovered, and two more periods preceding the pre-classical occupation, designated periods II and I. The remains of the first settlement resemble those of Troy I, approximately 2500 to 3000 B.C. One of the most important results of the season's work was the establishment of the local periods and the relative chronology of the pottery.

COMMENDATION

In view of the criticism and unfavorable comment recently aroused by the policies of many museum collectors, the following editorial which appeared in the *Anchorage Daily Times* of Anchorage, Alaska, November 7, 1927, is most gratifying to the American Museum:

How Museum Expeditions Should be Conducted

Several months ago *The Times* published an editorial criticising the so-called museum hunter. In glaring contrast to some of the expeditions that have visited Alaska in the past was the recent expedition of Mr. Van Campen Heilner, field representative of the American Museum of Natural History in New York.

As an illustration of how the museum permit should be used, when in the hands of a bona fide representative of a great museum—who does not happen to be a game hog on the side—Mr. Heilner came to Alaska with a permit for four brown bear, a male, a female, and two cubs. He came alone. In addition to his permit, he took out a nonresident hunting license, for which he paid the regular fee of $50.00. This license permitted him to take three additional brown bear. The average person would have done so. Mr. Heilner saw nearly thirty bears and could easily have secured the three bears, that his own license permitted, but he didn't. The four bears that the museum needed were taken, and no more.

Alaskans want to encourage accredited representatives of a museum of the standing of the American Museum of Natural History in New York, to come to Alaska and secure a needed group, so that thousands may see them and by seeing them realize the wonderful possibilities that Alaska offers to sportsmen. Alaskans do not want the game hog, who through political influence secured the required permit to slaughter our game, under the pretext of representing a museum, and thus satisfy his lust for killing. Regardless of the amount of money such persons may spend on their hunt, to permit this condition is not fair to the sportsmen of America, nor to the Alaska game commission and Alaskans in general.

Mr. Heilner in addition to being on the staff of the American Museum of Natural History, is associate editor of Field and Stream. It is sportsmanship like his that is appreciated. Alaskans hope he will come back again and they will stand ready to welcome him and assist him in securing any specimens or trophies he may desire.

HONORS

At the last meeting of the American Association of Museums Dr. Frederic A. Lucas was made an honorary member. Doctor Lucas was one of the founders of the Association, the third president, and for many years took an active part in the work of the Association.

ALLEN MEMORIAL FUND

THE JOEL ASAPH ALLEN MEMORIAL FUND, created by contributions from the mammalogists of the world in memory of the late distinguished curator of mammals of the American Museum of Natural History, reached its goal at the recent meeting of the Society of Mammalogists in Washington. Ten thousand dollars have been raised for this fund, which is to be used in the publication of special papers in the *Journal of Mammalogy* in memory of Doctor Allen.

Doctor Allen, who for thirty-six years was on the staff of the American Museum, was pre-eminent in the fields of mammalogy and ornithology and was virtually the founder of mammalogy as we now know it. The scope and length of his bibliography are equalled by few men in his field of research.

The members of the committee of the Allen Memorial Fund are: Madison Grant, chairman; Henry Fairfield Osborn, Childs Frick, George Bird Grinnell, and H. E. Anthony.

BOOK REVIEW

Wild Animals Pets. By William and Irene Finley. 311 pages and more than 80 half-tone illustrations. Charles Scribner's Sons, New York, 1928.

Few human beings have had so many wild animal friends as have the Finleys, and no one has made so many good photographs of birds and animals as they. In this book they have given us an intimate glimpse of more than a score of these "children of the wild," their fascinating stories being copiously illustrated by their own appealing pictures. The foreword was written at Riverby, Jennings Lodge, Oregon, named for John Burroughs' home on the Hudson. Unlike their hero, however, the Finleys have not confined their observations to the wild life about their cabin, but have traveled from the Pacific to the Atlantic, and from Mexico to Alaska. By the way, John Burroughs, in his journal nearly twenty-five years ago, as quoted in *The Life and Letters*, predicted that this young bird enthusiast, Finley, would be heard from.

For the benefit of less experienced photo-naturalists, some good hints are incidentally given, for example, "One thing is certain—if a cub ever gets in trouble or in a tight place,—this is sound advice to any sympathetic citizen: 'Get as far away from Johnny as possible!' Trying to reason with or to be sympathetic with a worried mother bear is too much like creeping up to find out why a charge of dynamite doesn't explode."

"Coyote, the Prairie Wolf" is a dramatic story well told. The account of the chipmunks of Mount Ranier is an interesting bit of animal psychology. Surely one of the most appealing motion pictures the Finleys ever made was that of the chipmunks.

The race between the pet pronghorn and the Russian wolf-hound enthralls the reader, but the race for life between this doe of the desert with her fawns against the coyotes is dramatic beyond words.

By the publication of *American Birds* twenty years ago, William Finley established himself as a genuine field-naturalist, with a keen and sympathetic understanding, and all who have followed his activities realize that he has had an able associate in Mrs. Finley, and two fine assistants in their children.

Both of these authors are so modest that the reader gathers little notion of the great amount of time and energy that has gone into this work. The book is all the better for that fact, however, for who would refer to any enterprise by the prosaic term "work," when so much real enthusiastic play has gone into it!

Adverse criticisms, which can be made by the reviewer, are relatively so insignificant that it seems hypercritical to make them. No mistakes in natural history were noted in the entire book. However, one might infer from the last sentence of the middle paragraph of page 134, that a mole is a rodent. On page 164, why state that the pupil of the eye was black? It is always black. On page 264, it should be clearly stated that newborn opossums crawl to the mother's pouch; at least one should not be allowed to infer that the mother puts them into this nursery.

But let not these trifling matters detract from the value of the book. Here are brought together some most interesting stories of birds and animals by two outstanding and dependable field-naturalists. Although not devoted to preaching, this collection of stories will do great good with plastic youth, our future citizens, in creating an interest that will work toward preserving the remnants of our wild life "as a part of our great museum of the out-of-doors."—CLYDE FISHER.

NEW MEMBERS

SINCE the last issue of NATURAL HISTORY, the following persons have been elected members of the American Museum, making the total membership 10,323.

Associate Founder

Mrs. HENRY C. FRICK.

Patrons

Mrs. FREDERIC W. STEVENS.
Miss SHIRLEY FARR.
Messrs: JAMES N. HILL, T. W. LAMONT, HENRY M. SAGE, S. B. THORNE.

Fellows

Doctors GEO. BIRD GRINNELL, LEWIS R. MORRIS.
Messrs: LINCOLN ELLSWORTH, ANTON G. HODENPYL, ANDREW G. C. SAGE, WILLIAM BOYCE THOMPSON, J. NORMAN DE R. WHITEHOUSE.

Corresponding Members

Fathers TEILHARD DE CHARDIN, J. G. HAGEN.
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